

Compressed Air

Magazine



MAY 1960

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NEW JPL WIND TUNNEL
GAS LIGHTS' LINEAGE
BUBBLES ON THE ESCANABA
SILENCE AT SUNSET MINE
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759-A-21

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Ann Arbor, Mich.



Bethlehem Wire Rope Helps Clear Way for Mountain Highway. This action photograph shows Bethlehem 1 $\frac{1}{8}$ -in. shovel hoist ropes at work on a recent road relocation project atop Broad Mountain, on Pennsylvania's winding Route 29. The contract, supervised by the Pennsylvania Dept. of Highways, called for the removal of 900,000 cu yd of sandstone and earth.

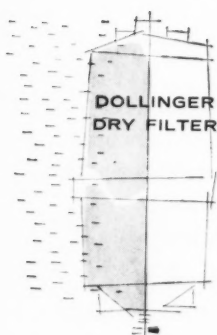
On this job the Bethlehem wire rope is subjected to hard usage, day after day. Yet it keeps coming back for more—just as it is doing in thousands of construction jobs all across the land.

Bethlehem Steel Company, Bethlehem, Pa. *Export Distributor:* Bethlehem Steel Export Corporation

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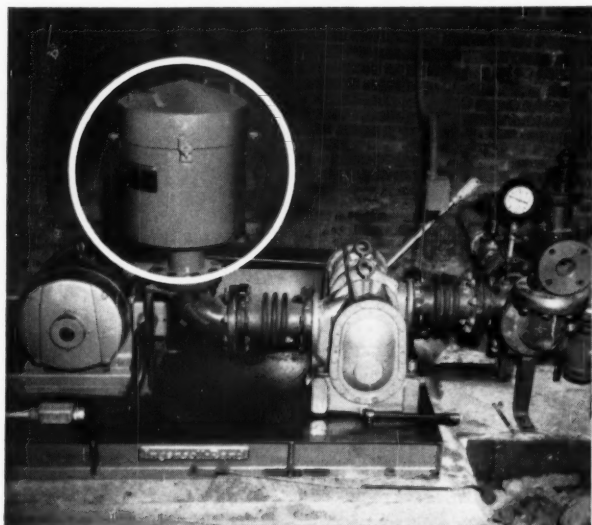
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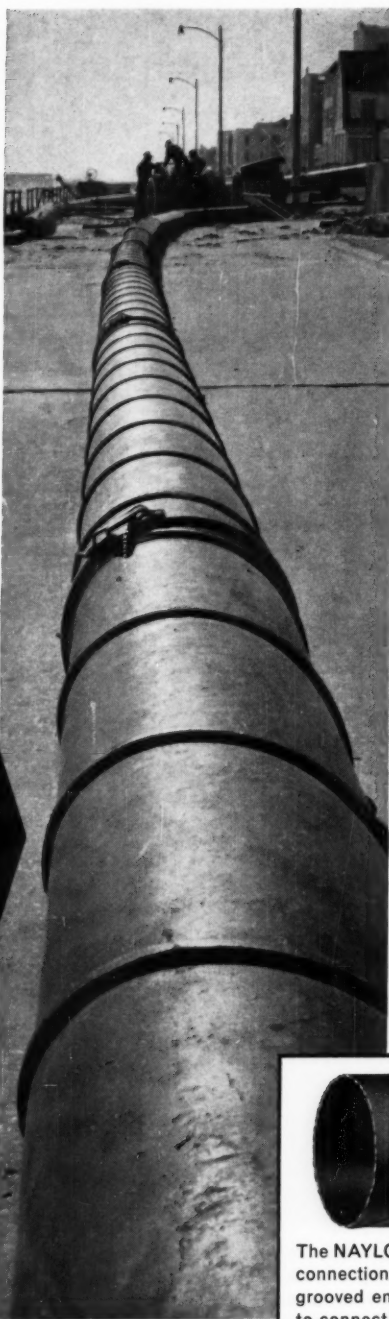


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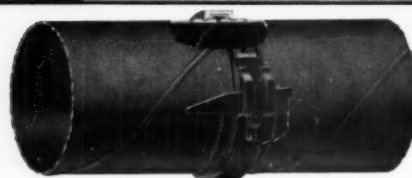
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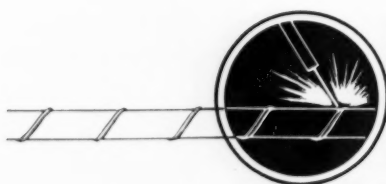
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Compressed Air

MAGAZINE

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on the cover

In line with the vacation season, which is again uppermost in everyone's mind, our cover presents a scene from one of the world's famous holiday boulevards—Main Street, U. S. A. Visitors to this West Coast playground walk by shops and theaters operating as they might have more than 50 years ago. To add to the atmosphere, gas lights were brought to Disneyland from Baltimore, Md. "By the Light of Gas," in this issue, gives a historical glimpse of an illumination that was all the rage when *Heart of a Waif* was playing at the "Main Str. Cinema."

10 Test Speed: Mach 9.5—R. J. Nemmers

Jet Propulsion Laboratory first dipped its scientific toe into the study of rockets in 1936. Since then the Caltech R&D facility has been a leader in U. S. aeronautical and space research. Its new wind tunnel, whose centrifugal compressors can blow winds continuously at hypersonic velocities, is described here in detail.

16 By the Light of Gas—S. M. Parkhill

It is easy to find examples of gas lights today for they are enjoying widespread popularity. Their long and colorful history is high lighted in this article. The current revival will be discussed next month.

20 Bubbles Protect Refurbished Dam—Paul Ziemke

Forty-one years of winter in the Upper Peninsula of Michigan could weary any dam. Engineers of the Mead Corporation refaced theirs with concrete, then installed a pneumatic bubbling system to ward off ice.

22 Sunset Mine's Sad Story—John Diebold

Where copper ore and high hopes were once raised, only a few crushed buildings and quieted machines now lie. A Washington State mine's past is chronicled in this story.

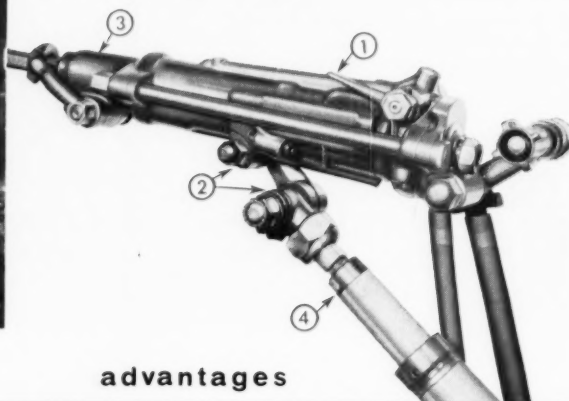
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the *new* JR-38C UNIVERSAL JACKDRILL

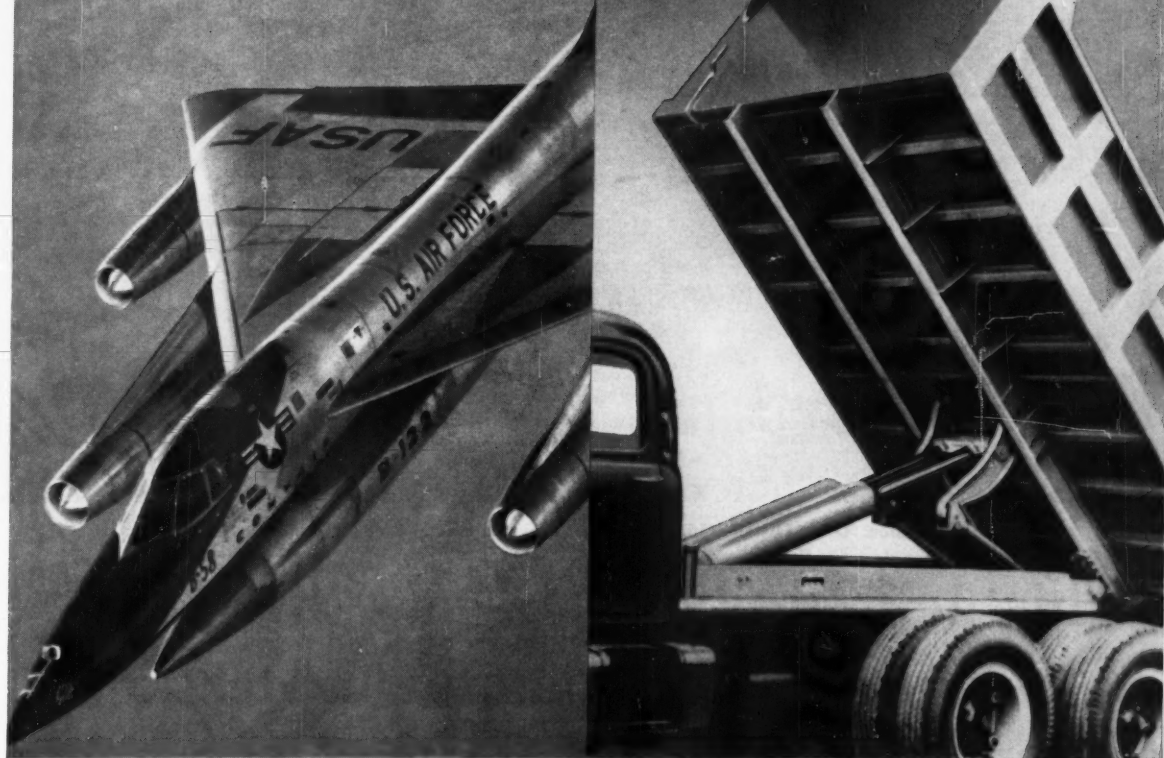
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<p>For <i>drifter</i> dependability in a light-weight feed-leg drill, try the new JR-38C. Ask your I-R distributor or engineer for complete information.</p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div> <p>Ingersoll-Rand 104AS 11 Broadway, New York 4, N.Y.</p> </div> <div>  </div> </div>	

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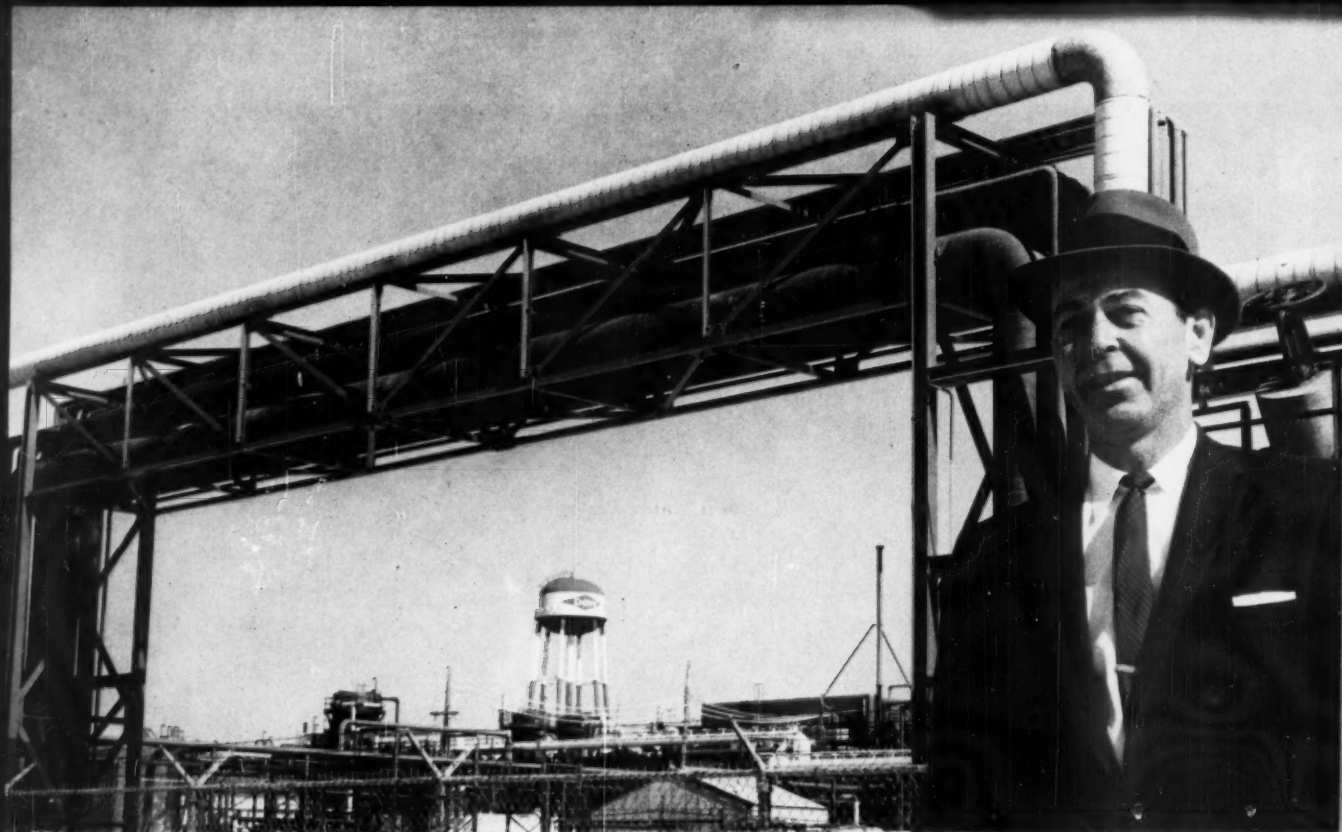
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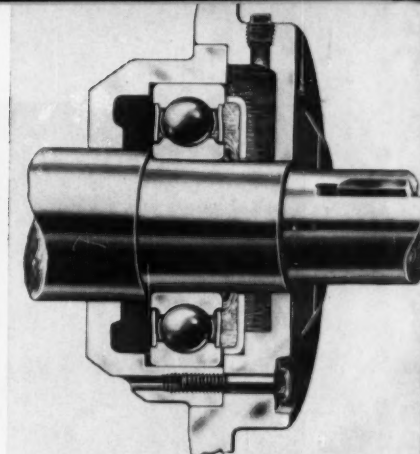
Duty Master
A-C. MOTOR



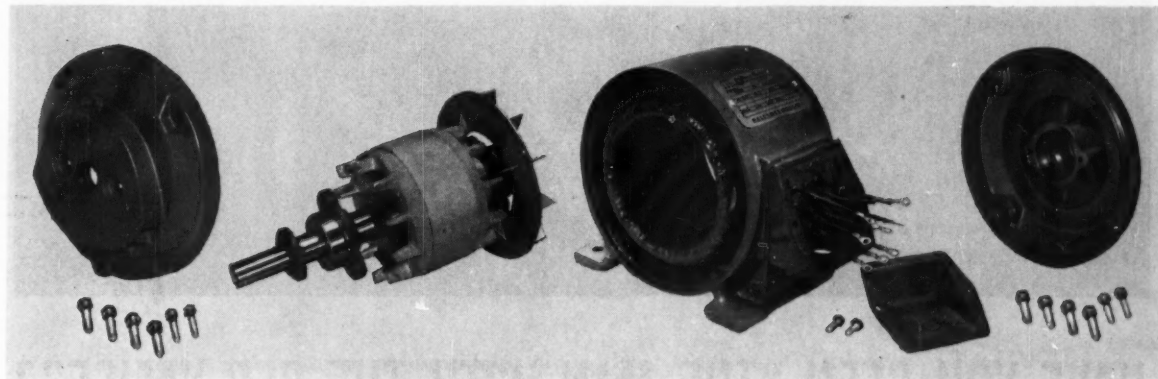
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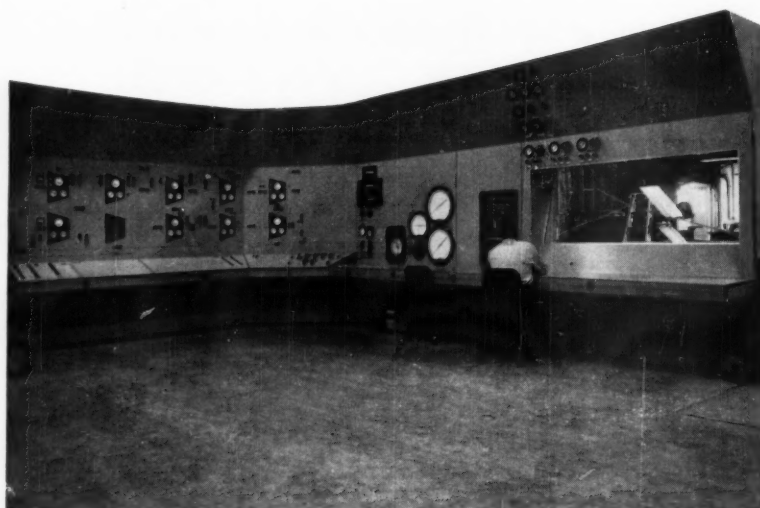
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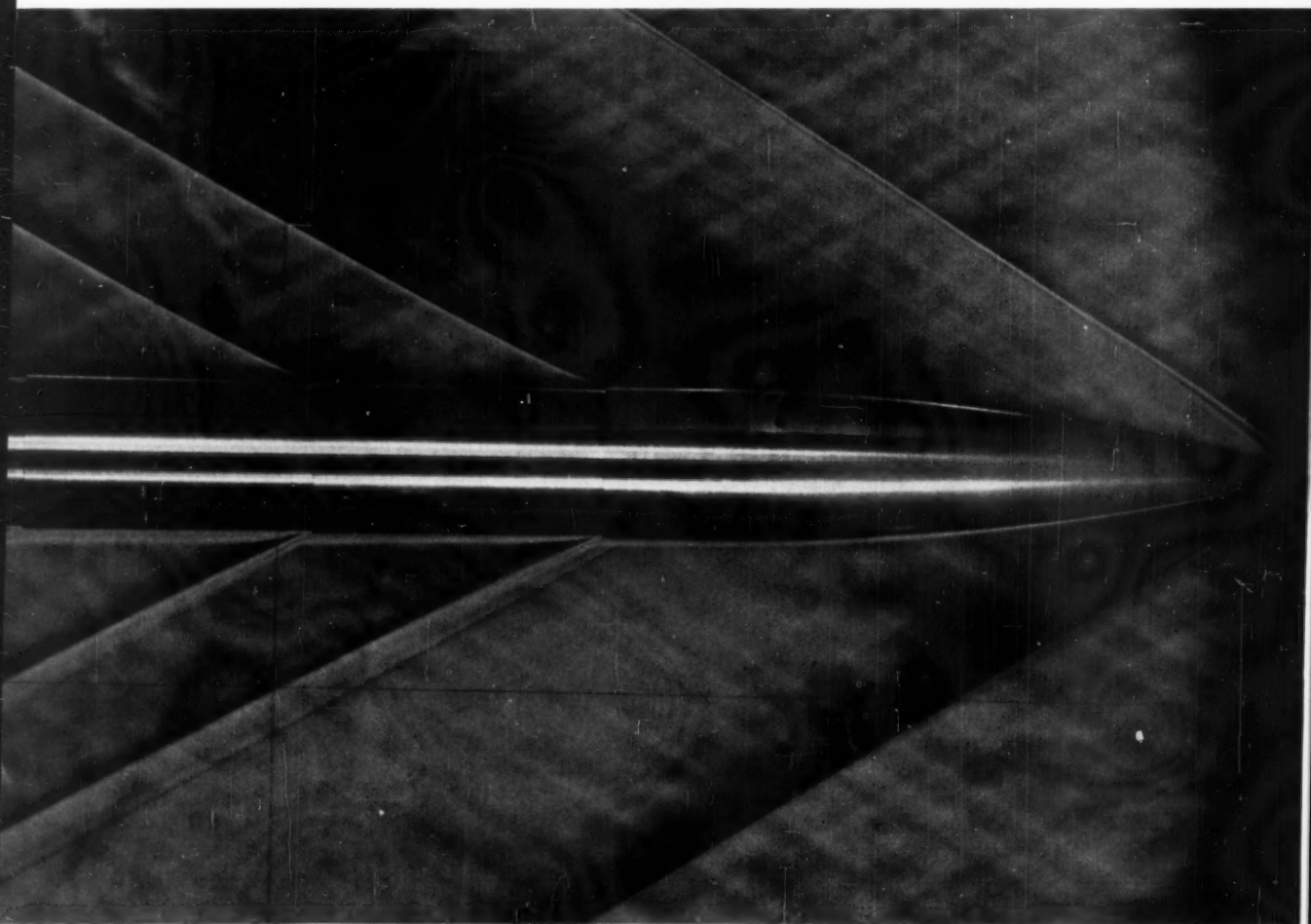
Planned Annual Retooling
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36A-8

SCHLIEREN FLOW When air at high speeds flows over an aerodynamic surface, it bounces off in a succession of waves. The change in density of air causes a change in its refractive properties, thus the flow lines can be viewed with the unaided eye. The effect is pictured at the bottom of the page, the original photograph having been taken in the 20-inch, supersonic tunnel. At the right is the control room for the JPL hypersonic tunnel.



TEST SPEED: MACH 9.5



The California Institute of Technology Jet Propulsion Laboratory has completed installation of a \$3,500,000 continuous-flow hypersonic wind tunnel for air speeds of Mach 5 to Mach 9.5. When all compressor equipment is in place, a total of 27,000 hp of capacity will be available for the hypersonic tunnel and two supersonic tunnels.

R. J. Nemmers

EXPLORING space is the job of three of the free world's best equipped continuous-flow wind tunnels that are firmly anchored to the ground in Pasadena, Calif. Installed at Caltech's Jet Propulsion Laboratory the three units can test missiles and aircraft and their components at air speeds of from Mach 1.3 to 9.5. When the last of two centrifugal compressors now being installed is in place, the compressor plant for the three tunnels will be made up of eleven machines with an aggregate 27,000 hp.

JPL, as the lab is known, is a research and development facility operated by the California Institute of Technology under contract with the National Aeronautics & Space Administration and performs work for NASA, the Army Ordnance Corps, and other contractors. Besides the Pasadena installation, which is valued at more than \$27 million, JPL operates external test and tracking facilities at Edwards Air Force Base and Goldstone Tracking Station, Calif.; White Sands Missile Range, N. M.; and the Atlantic Missile Range, Cape Canaveral, Fla.

JPL has a rocket research history dating from 1936 when Caltech's Guggenheim Aeronautical Laboratory (GALCIT) initiated a program in this field under the leadership of Professor Theodore von Karman. In May 1939, the first supersonic wind tunnel in the nation with a useful working size was designed and built by GALCIT. This early model was sponsored by the Army Ordnance Corps. Again, in 1946, a model hypersonic tunnel was built at GALCIT also under an Army Ordnance contract. (*Supersonic* tunnels test between Mach numbers 1 to 5; *hypersonic* tunnels, above Mach 5.)

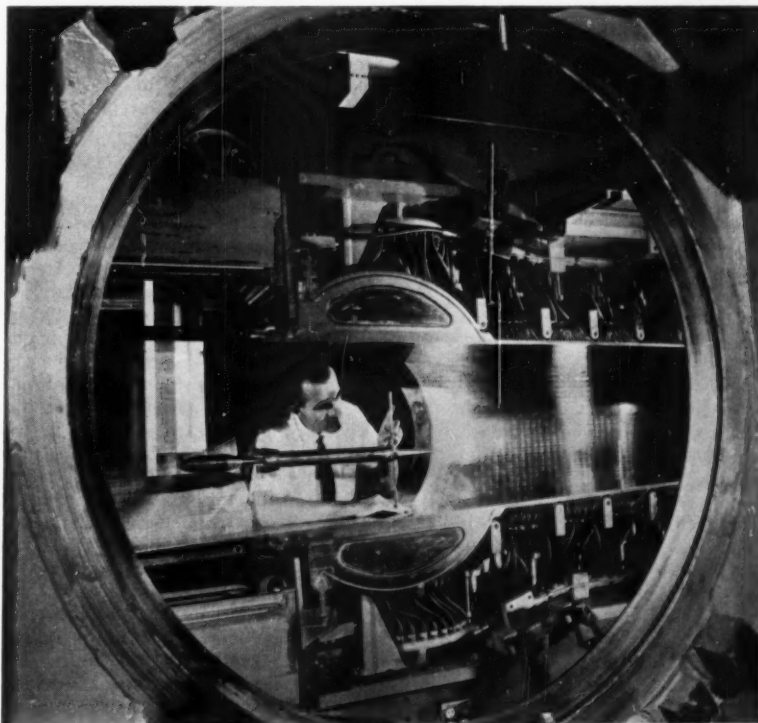
The following year, JPL built a 12-inch tunnel (one having a test section 12 inches high and 12 inches wide) for testing in the Mach range of 1.3 to 4. This tunnel is one of three presently operating at the laboratory. In 1951, the second supersonic tunnel was con-

structed. Having an 18x20-inch test section, the larger tunnel is used at speeds from Mach 1.3 to 5. The recently completed hypersonic tunnel for speeds from Mach 5 to Mach 9.5 was also funded by Army Ordnance and has a 21x21-inch test section.

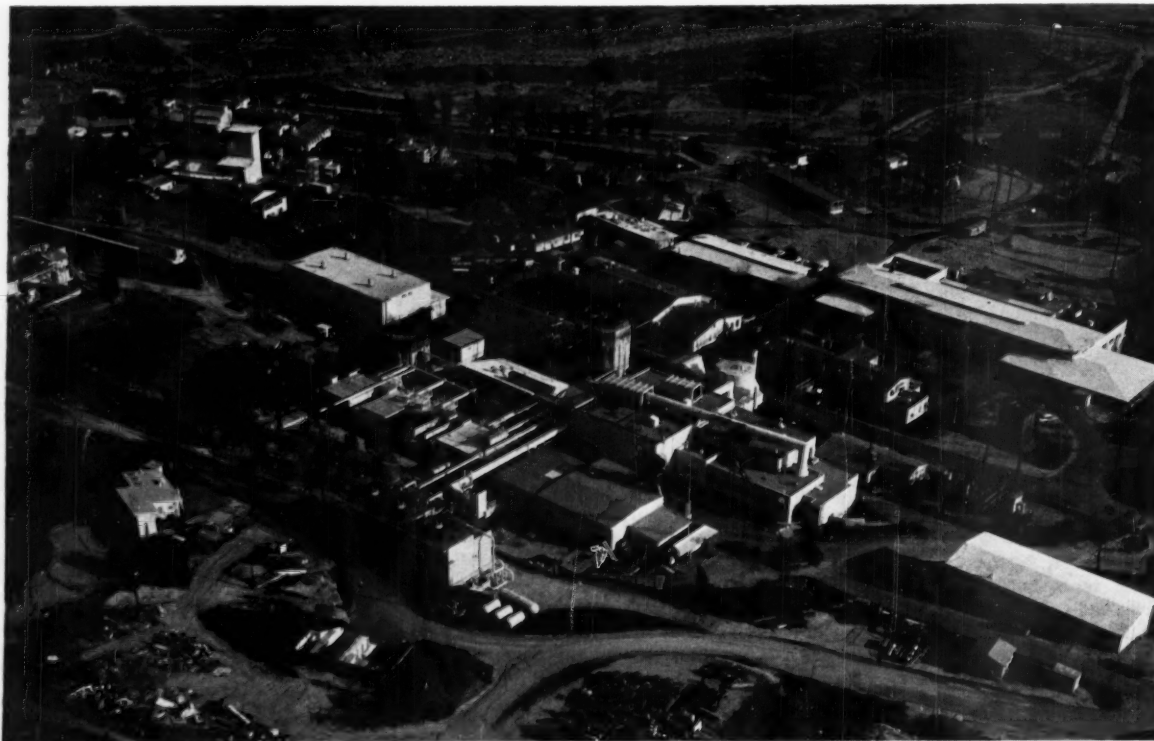
The achievements of JPL read much like a compilation of the nation's major research efforts in the field of missiles and aircraft. In 1941, for example, it originated and designed the first successful jet-assisted takeoff (JATO) units.

The *Wac Corporal* which set an altitude record of 43.5 miles in 1945 was a JPL product. So, too, was the *Bumper Wac* which, in 1949, soared to the then record altitude of 250 miles. The *Corporal*, first of the ballistic surface-to-surface missiles, came from the lab. In collaboration with the Army Ballistic Missile Agency, *Explorer I* was launched in 1958. *Pioneer IV*, the nation's first successful moonspace probe in March 1959 was a product of the same groups. Furthermore, JPL has pioneered in the development and operation of continuous-flow flexible-nozzle supersonic wind tunnels to the advantage of many of the free world's latest and most elaborate installations. The laboratory has also been involved in much of the basic research covering experimental high-speed aerodynamics.

The new hypersonic tunnel will be used to study stability and control problems on many of the nation's most advanced missiles and aircraft by means of force balances and pressure distribution measurements. Heat transfer on practical shapes, and the effects of such things as angle of attack, interfering flow fields and separated flow regions, both with and without various means of cooling, will be studied experimentally under



TEST MAKE-READY A model of the U. S. Army's Sergeant missile is shown here being positioned for a test run in the hypersonic tunnel. The test models are suspended on a variety of mounts, eight basic types being used. Independently supported air foils direct air around the support mountings thus isolating the aerodynamic loading on the model surfaces. As a "just-in-case" precaution, a model catcher made of stainless steel bars protects the aftercooler tubing from model parts, or even full models, that are torn away by the high-speed air flows.



OVER-ALL VIEW The \$27 million JPL installation is shown here. The main test buildings of the laboratory are in the center complex surrounded by power substations, cooling towers, etc. The administrative offices are at the upper right. The large conduit running above the test structure is the return line for the 20-inch tunnel.

carefully controlled conditions. The tunnel is limited to studies where high temperatures are not a problem. Nor can real gas phenomena such as dissociation and ionization be simulated.

Tunnel Design

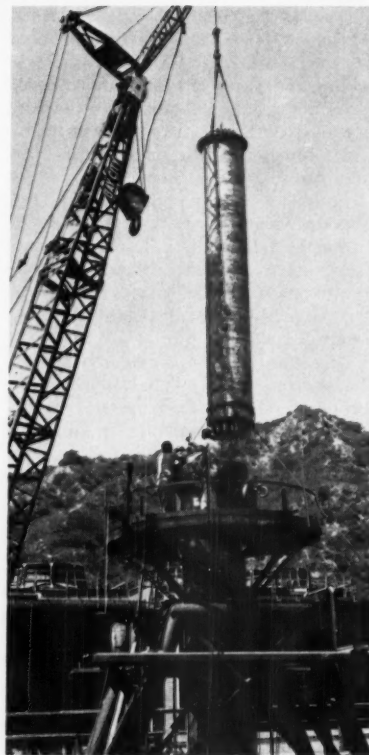
In many superficial aspects, the three tunnels are quite similar. Each makes use of flexible steel nozzle plates at the top and bottom of the working section which can be contoured to fit the requirements of any given test within the capacity of the tunnel. The plates are warped into shape on the 12-inch tunnel by twelve pairs of manually operated screw jacks. On the 20-inch one, the configurations required are attained by means of 22 pin-ended jacks controlled by servo-mechanisms. Each servo is in turn regulated by individual cams moving in unison on a control shaft which is positioned at will to alter the warp of the nozzle plates. In the new hypersonic tunnel, the flexible steel plates (14 feet long, $\frac{1}{2}$ inch thick, 17 inches wide at the throat and 21 inches at the test section) are each contoured by a

system of sixteen hydraulic jacks. Refinements in position of as little as 0.0005 inch are possible in adjusting the nozzle configuration to within 0.00025 inch of the theoretical shape specified.

The Throat

Although the supersonic tunnels pioneered the use of flexible nozzle plates in establishing contours, the hypersonic tunnel goes one step further. In the supersonic tunnels the throat as well as the flexible top and bottom plates are made of stainless steel. In the hypersonic, solid, water-cooled beryllium-copper blocks are used for the sonic throat. The high strength and high thermal conductivity of beryllium-copper, it was found, was more suitable for this most important of the tunnel's components. It is actually the setting of the throat blocks (in two dimensions) that determines the Mach number at which the tunnel will operate. The blocks are the most important part of the tunnel and they were the hardest to manufacture. Their curved surfaces had to be machined to tolerances of 0.0002 inch. The need for such critical control is evident in the settings for operation of the tunnel at Mach 9: the width of the rectangle formed by the adjustable blocks is 17 inches; its height, only 0.045 inch.

The throat blocks are equipped with an integral coolant circulation system passing 1475 gpm at a velocity of 120 fps. The maximum air supply pressure im-



LOWERING IN Eighty-one Nichrome tubes make up this air heater that prevents the formation of liquid air in the tunnel test section. The 4200-v unit can raise the input air temperature to as high as 1300° F.

posed on the blocks is 1000 psig at 1350° F. This temperature is not a test or experimental condition—rather it is a requirement for operation. At Mach 9 speeds, the air must be preheated to that temperature, otherwise, during its extreme expansion through the narrow throat, droplets of liquid air would be formed.

Air Flows

The air supply for the three tunnels is dried by first being refrigerated to 0° F. The refrigeration plant has a capacity of 135 tons. Subsequently air is passed through an activated alumina drier. The 40-foot-high vessel holds 400,000 pounds of desiccant and reduces the dew-point of the air supply stream to at least minus 40° F.

The pattern of air flow differs but slightly between the supersonic and the hypersonic tunnels. In the under-Mach-5 range, compressed air flows through the supply section at subsonic speeds to the throat and nozzle. There it expands to a low static pressure and temperature and races at supersonic speeds through the test section. It then enters a diffuser which operates just as does the diffuser in a centrifugal compressor to slow the air, converting the energy of velocity to that of pressure. At the same time it regains most of the heat given up in expansion. Leaving the diffuser, the air then returns to the compressors to start the cycle again.

In the hypersonic tunnel, as we have said, the air must be heated to avoid liquefaction. This is done in a 4200-kw electric heater placed between the compressors and the supply section of the tunnel. The 81 heating elements of the device are made up of concentric pairs of 22-foot-tall Nichrome tubes through which the air makes a single pass. A potential of 4000 v applied across the tubes brings wall temperatures to as high as 1600° F. A saturable reactor, thermostatically governed, regulates the power supply to maintain a constant output (air) temperature.

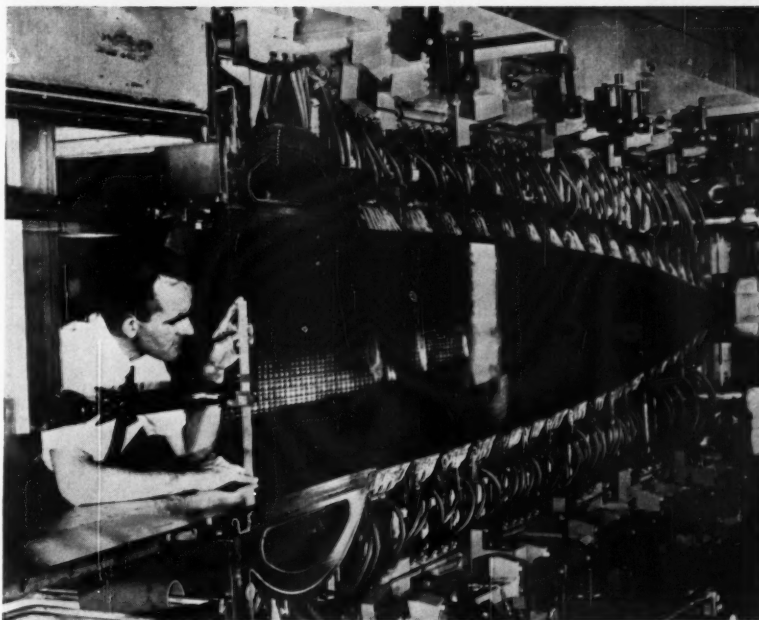
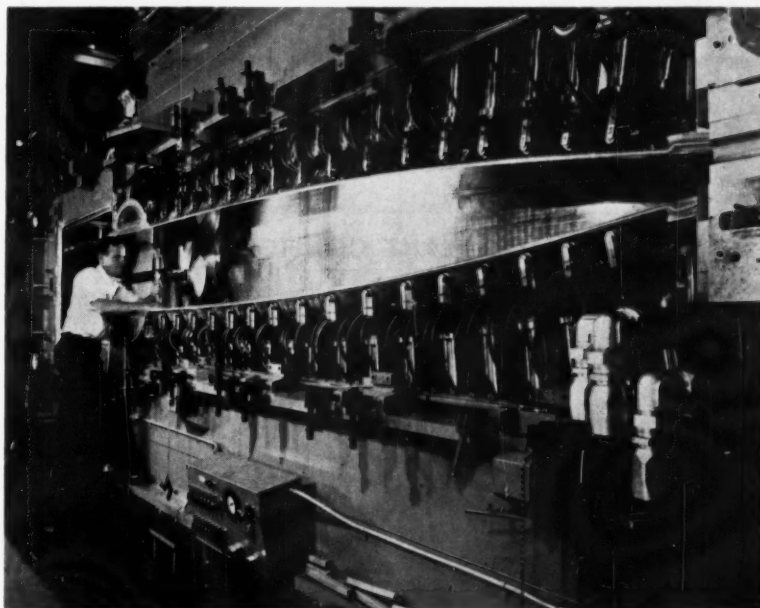
The heated air then passes through the hypersonic throat and into a diffuser. At the diffuser exit the air temperature is about 1000° F, thus it is necessary to cool the cycling air before returning it to the compressors (at about 150° F). The tunnel aftercooler was selected to provide reliability against water leaks into the dried air stream. The exchanger has 6800 square feet of cooling surface in 1664 tubes and requires a coolant (water) flow of 2400 gpm.

Hypersonic Cooling

Because the supply system for the hypersonic tunnel has to be at such high temperatures, many cooling problems are presented in maintaining dimen-

sional stability of critical parts. The throat itself is the most difficult of these because of the tremendous amount of heat that must be removed from the relatively small area. The outer surface of the throat is at a temperature of 1200° F and the coolant itself flows in contact with surfaces that may reach 120° F

temperatures. Because of this, a separate throat cooling system was installed to use water treated to avoid scale formation. The entire system is pressurized to prevent cavitation at the high flow rates. This system also supplies cooling water to other air supply components where air temperatures exceed 400° F.



TUNNEL VIEWS Looking upstream (top) and downstream at the tunnel test section. The hydraulic cylinders that warp the top and bottom plates of the hypersonic 21-inch tunnel test section are visible in these views. Side plates of the tunnel are fastened in place with quick-acting toggle clamps for easy removal. During tests, silastic tubing forms a tight seal between the upper and lower plates and the side panels. The tubing is air-inflated, an Ingersoll-Rand Type 30 compressor being installed to furnish air at 500 psig for that purpose. Each side plate has two 30-inch access doors, the upstream one on either side having an 18-inch-diameter Corning quartz window for Schlieren viewing of tests.

Air Supply

By careful selection of compressors for the tunnel air supply, JPL has been able to provide maximum availability of all tunnels for test operations; to provide, under certain conditions, for stand-by operation of either the hypersonic or both supersonic tunnels; and, in the future, will be able to operate all tunnels simultaneously.

The well-integrated air plant was established in 1947 for the original 12-inch tunnel which required a compressor plant of continuous 4000-hp rating. This plant was made up of four centrifu-

gal machines, all of Ingersoll-Rand manufacture. Two designated "D" and "F," are MGA-352 units of 1000 hp each. The other two, "E" and "G," are MGA-340 units, also of 1000 hp. All four are driven by General Electric induction motors through Westinghouse speed increasing gears.

Next to be installed were the compressors now designated "A," "B" and "C." Also I-R units, the machines are identical MGA-3100 centrifugals, and are driven at 3570 rpm through G-E gears by individual Westinghouse synchronous motors of 4000-hp rating.

When the hypersonic tunnel was put

into operation, provisions were made to supply it with air from all of the above compressors piped in seven stages with two additional machines purchased especially for the task. Designated "J" and "K" in JPL parlance, these machines are MGA-633 units, both driven at 8905 rpm through Westinghouse gears by G-E 2000-hp synchronous motors.

The latter arrangement, coupling compressors "A" through "K," was satisfactory only on a short-term basis because neither of the supersonic tunnels could be operated while the hypersonic tunnel was in use. This necessitated a separate operating shift for investigations in the below-Mach-5 range. The speed-up of missile and aircraft research also indicated the need for more compressor capacity, thus machines "L" and "H" were ordered and are now being installed. Also Ingersoll-Rand units, these machines have a combined rating of 7000-hp bringing the total for the plant to 27,000 hp. Unit "L" is an MGA-5112 centrifugal.

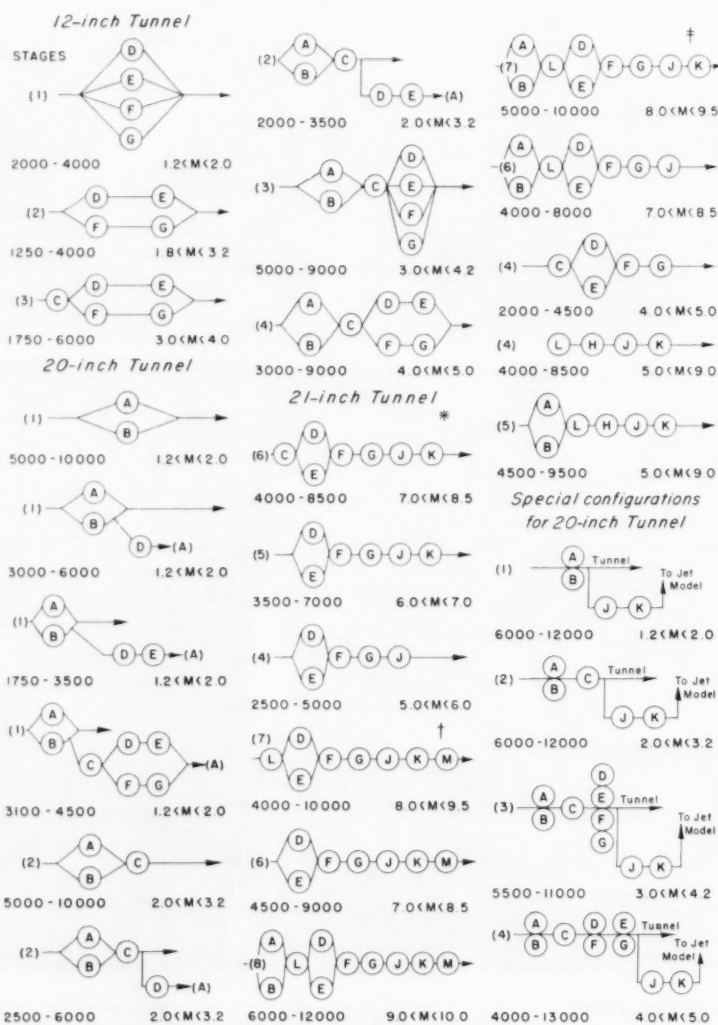
Compressor "H" is an MGA-5D-IC unit with a 22,000-cfm capacity. This type of machine is equipped with inter-stage cooling for a near approach to the ideal isothermal compression. It is built in five stages and has been offered for use as a 100- to 125-psig plant air compressor with deliveries to 35,000 cfm. Four straight-tube coolers for between-stage heat extraction are built right into the base of the machine and all piping is integral with the unit. As shown in the accompanying table of compressor specifications, the so-called CVM unit at JPL operates at a compression ratio not greatly different from a standard 100-psig machine.

Compressor Specifications

Machine	Inlet Pressure	Outlet Pressure	Capacity (cfm)
A	14.1 psia	16.5 psig	57,000
B	14.1 psia	16.5 psig	57,000
C	14.1 psia	16.5 psig	57,000
D	14.1 psia	15 psig	14,000
E	14.1 psia	15 psig	8,000
F	14.1 psia	15 psig	14,000
G	14.1 psia	15 psig	8,000
H	6.2 psia	47.8 psig	22,000
J	48 psig	193 psig	3,500
K	188 psig	498 psig	1,075
L	3.82 psia	14.5 psia	82,000

An elaborate pipe net interconnects the compressors so that by proper setting of the valves virtually any combination of the machines can be put together for a wide variety of final pressures and capacities. For example, units "A" and "B" form the first stage of seven, "C" the second, "D" and "E" the third, "F" the fourth, "G" the fifth, "J" the sixth and "K" the last, in a hook-up that delivers an ultimate 700-psig-pressure air stream to the hypersonic tunnel for tests in the Mach range from 8 to 9.5. Other

COMPRESSOR PLANT CONFIGURATIONS



Notes: Figures in parentheses at left of each schematic are the number of stages of compression in each hook-up.

Figures at lower left of each schematic define the horsepower range.

Figures at lower right give the Mach number range—that is, for the first sketch, the hook-up is suitable for tests at speeds greater than Mach 1.2 and less than 2.0.

* Compressor "L" can be used in place of "C."

† Compressor "H" can be used in place of "F."

‡ Compressor "C" can be used in place of "L."

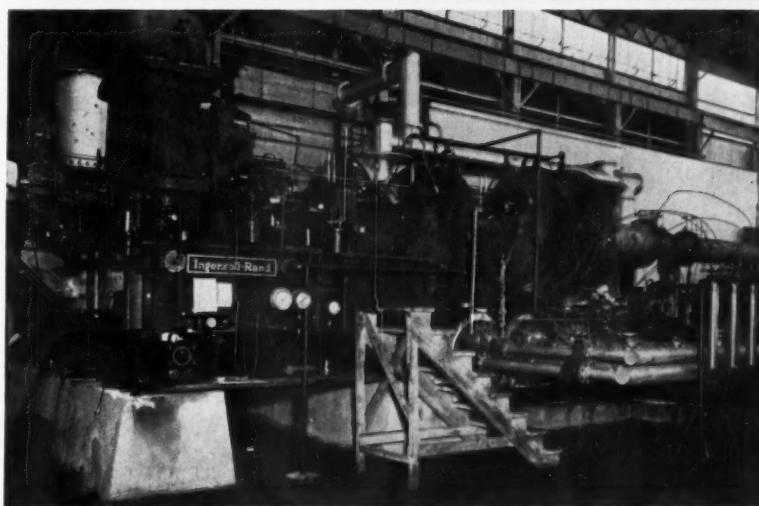
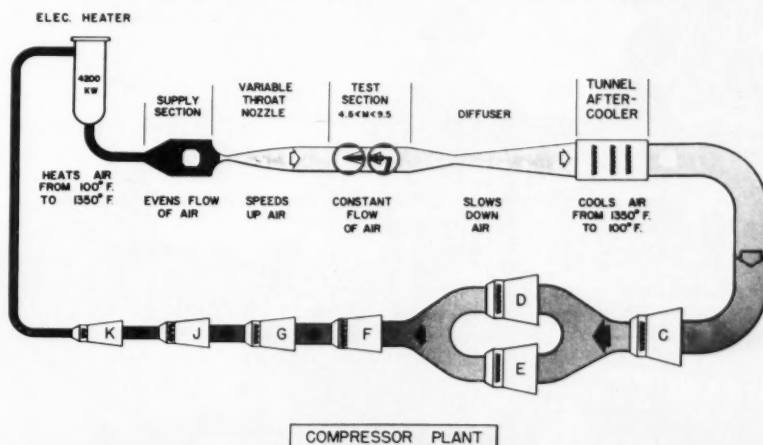
configurations of the compressor plant are shown in an accompanying table along with the various horsepower requirements of each and its respective Mach number range.

As an indication of the complex nature of the air plant, before the 21-inch tunnel was installed, about 900 feet of larger diameter air piping was required, served by 50 main air valves, some 300 push buttons, nearly 1000 indicator lights, meters and gauges and about 600 control and auxiliary relays. When the new tunnel was installed it meant that valves, controls, piping, etc., increased from 25 to 60 percent. In addition to the valving that enables the compressor configurations shown herewith to be achieved, there is a bypass that cuts across the entire plant permitting the compressors to operate during model change-over. A throttling valve in this bypass also permits the compressors to be run at the required compression ratio before a tunnel test is actually initiated.

Besides all of the controls having to do directly with compressor and tunnel operation, a number of safeguard controls protect the equipment. Safety interlocks between valving so that air cannot flow from pressurized lines to machines not in use protect the compressors from being run backwards (not a particularly damaging situation in itself, but potentially damaging because of the lack of oil normally pumped to the bearings).

The service record of the compressors to date is excellent, even without considering the rigorous conditions imposed by wind tunnel operation. Comparable machines in industry operate many months without wear-causing shut-downs and start-ups, yet at JPL, about 500 starts per year is normal practice. Beyond the conservative ratings of the compressors and their heavy-duty design, the primary reason for the low level of compressor outages is an effective preventive maintenance program that covers not only the compressors but motors, pumps, gear boxes, etc.—in effect, every piece of “hardware” in the plant. Furthermore, it is apparent that the way in which the compressors are operated (started, stopped, brought up to load, taken off the line in an emergency and the like) will have a great bearing on the serviceability of the machines. At the laboratory, operators are carefully trained and then further aided by carefully prepared procedure sheets set up for each type of test program. Working to these standards, within the limits imposed by the test program, has relieved many of the strains that the compressors might otherwise undergo in being started and stopped several times a day. This system also aids in the training of new compressor operators for a job that many at the lab feel is almost equal parts of art and science.

AIRFLOW SCHEMATIC—21-INCH TUNNEL



WIND SUPPLY Compressors “J” and “K” (middle picture) are each 2000-hp units. Compressor “H” (bottom view) is shown while on test at the manufacturer’s plant. The 3000-hp Ingersoll-Rand MGA-5D-1C unit has a rated capacity of 22,000 cfm.

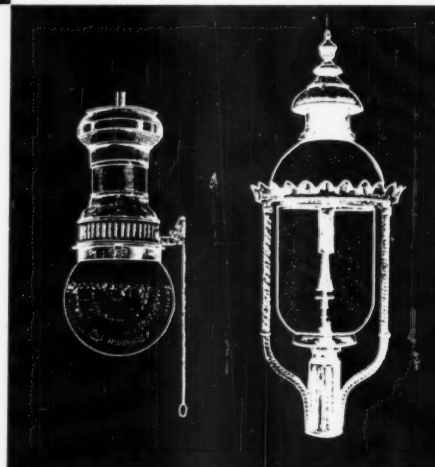


N. MAIN STREET A few original lights remain in Baltimore, however 31 of the Welsbach fixtures were taken to Main Street, U. S. A. in Disneyland to lend nostalgic atmosphere to the playground.

By the Light of Gas

The Historical Perspective

S. M. Parkhill



DOTTING boulevards and streets, doorways and patios, the gas light is again coming into its own. The current revival in the United States is rooted in the Southwest, but gas lights themselves have a noble heritage that spans many centuries.

A Wild Spirit

Although natural gas was the major factor in the initial widespread acceptance of gas lighting, the gas light actually owes its start to manufactured gas—coal gas. The Flemish physician, John Baptista von Helmont, experimenting with fuels, discovered "gas" in 1609. He dubbed it the "wild spirit" because of its strange uncontrollable properties. In 1664, Rev. Dr. John Clayton, a Yorkshire minister, drained water from a ditch near the market town of Wigan and found gas seeping from the ground and a nearby canal coal mine. Theorizing that there was a relationship be-

tween the two, he distilled the coal in a retort, collecting the gas produced in bladders. Then in 1786, a professor at Louvain University, Jean Pierre Mincklers, distilled many substances and was able to light his lecture hall with manufactured gas.

An early major contribution resulted from William Murdock's engineering work at Cornwall, England. He produced gas to light his Redruth cottage in 1792 by distilling coal in an iron retort. A cylindrical pot that held 15 pounds of coal was set in brick and heated by an open fire. The gas that issued forth was conducted some 70 feet through tinned iron and copper tubes. Murdock ran a small experimental plant in 1795, and a few years later lighted a factory in Soho with 900 of his Bengal Lights. This was publicly displayed in 1802, and as a result he is credited with the first practical application of gas lighting of any magnitude.

An employee of James Watt, Murdock

convinced him to light the Boulton, Watt & Company factory near Birmingham. This, and his previous experimentation, earned for him the Royal Society of London's Rumford Medal.

In September of 1799 an important patent was granted to Phillippe Lebon for a thermo-lampe—a self contained apparatus for the production of gas by distillation from wood, coal and similar solids. Eventually he was able to light his home and gardens in Rue St. Dominic, Paris—an event that received considerable acclaim in the local press and resulted in the spread of gas lights to England and eventually, America. Frederick Albert Wintzler (or Windsor), a German, read of Lebon's work and was enthusiastic. He took up the cause and on May 18, 1804, not only obtained the first English patent for gas making, but lighted London's Lyceum Theatre as well.

Londoners were considerably interested for they had long hung candles

outside on especially dark nights—a practice dating from 1416. (An Act of Parliament was even passed in 1661 to enforce it.) Oil lamps were later used; it was obvious to them that the new gas fixtures would be even better. On January 28, 1807, one side of historic Pall Mall was lighted with gas—its first practical application as street lighting. The mains laid for the job were made of sheet lead bent into cylindrical form and soldered. Wintzler supervised their laying and dreamed of lighting all of the British Isles. People were skeptical and feared London would be consumed by flames. Parliament was not enthusiastic either and did not readily grant a charter to Wintzler for this purpose. However, after 3 years of debate and much ridicule, a charter was granted to The London & Westminster Gas Light

& Coke Company—a utility that was under Wintzler's direction. It became the first gas company in the world operating on the central station concept to supply lighting service to the public.

Light of Science

Following the discovery of making gas from coal and the unparalleled success of gas lighting in a few European cities, Baltimore, Md., decided to try the scheme. The city fathers began with a promotional campaign to bring the citizens into a favorable attitude toward gas fixtures. Newspapers told of lighting in France and England and of earlier attempts by American inventors. The journalistic deluge culminated in 1816 with the sensational lighting of Rembrandt Peale's museum described

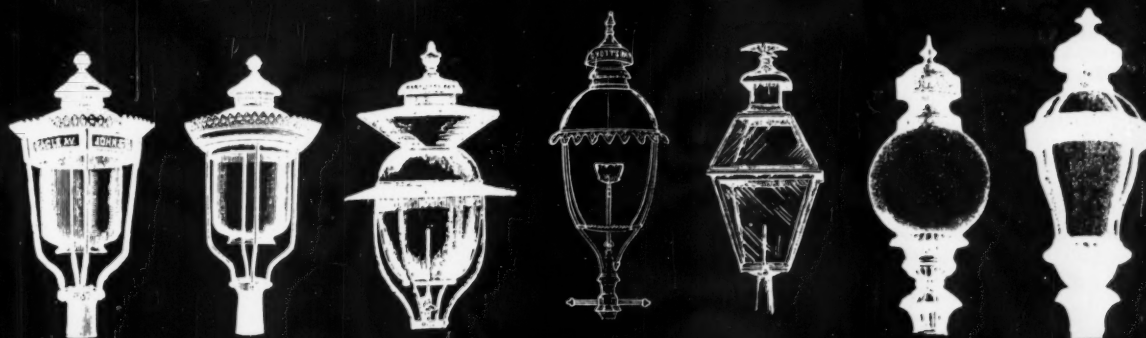
thusly in the June 12 issue of *The Federal Gazette and Baltimore Daily Advertiser*:

"Yesterday evening, for the first time, the citizens who attended at the Baltimore Museum were gratified by seeing one of the Rooms lighted by means of carburetted Hydrogen Gas. The effect produced by this beautiful and most brilliant light, far exceeded the most sanguine expectations of those who had not before witnessed an illumination by similar means."

The publicity efforts were apparently worth the trouble for shortly after the opening, Peale requested permission to light the streets of the city. Unlike Wintzler in London, he was quickly allowed to manufacture gas, lay pipes in the streets, and contract with the city for street lighting. A city ordinance was

Left to right: Humphrey inverted mantle lamp, Welsbach's street lamp (see photograph at the top of the opposite page), two Miner lamp designs, a Bartlett lamp, two Standard models, and two more of the Welsbach fixtures.

SKETCHES, AMERICAN GAS JOURNAL



FRANKLIN INNOVATION Gas lights in Independence Hall Park, Philadelphia, Pa., have four flat panes instead of globes because Benjamin Franklin thought they were easier to replace when broken. He wrote "with a long Funnel above to draw up the Smoke, and Crevices admitting Air below . . . they were kept clean, and did not grow dark in a few Hours, as the London Lamps do."

PHOTO, M. S. PARKHILL



passed on June 17, 1816, only 6 days after the museum was publicly displayed. It clearly stated that "the company shall not in any manner injure or displace any pipe or pipes laid or to be laid by the Baltimore Water Company for the purpose of conveying water into or through any part of the City or Precinct." People were still not completely confident in gas lighting.

Thus Baltimore became the first American city to commercially use manufactured gas, "The Light of Science" the Council called it. She also boasts the first gas utility in the United States—The Gas Light Company of Baltimore, predecessor of Baltimore Gas & Electric Company. It was incorporated on February 5, 1817, and among the founders was Rembrandt Peale.

The lights were turned on at the corner of Market and Lemon streets on February 17, 1817. They were considered something of a luxury. During the next 2 decades, only about 2 miles of mains had been laid and there were only a few customers. Gas was charged at a flat price of \$12, \$14 and \$18 per burner depending on its size. This practice continued until gas meters were manufactured in 1832.

In general, nationwide acceptance of gas lighting started slowly. Lamps were used first as street lights and later appeared in public buildings and homes of a few wealthy citizens. In the decade following 1865, however, gas for home illumination made great strides forward, thanks especially to the development of the natural gas industry.

The God's Breath

Probably the earliest use of natural gas for lighting appeared in Greece, but the light produced there is far-removed from that of the nineteenth century. Shepherds found a spot in the Hellenic hills where the air made them and their flocks feel lightheaded and giddy. Talk about the air spread; it was believed to be the breath of Apollo. A temple was created that was destined to become the home of the famed oracle of Delphi. What had actually been found was a natural gas seepage.

Fire worshippers were common, even during the 600's. Pilgrims made journeys to temples raised over natural gas deposits in Baku on the Caspian Sea. One such flame was still being used as late as 1880. When the structure surrounding it was razed at the turn of the century, a secret pipe was found leading to a rock crevice and a natural gas vein that produced the holy flame. Even in the East—in Japan, British India and Persia—the light produced by burning gas seeps was worshipped.

Gas was well-known in the United States prior to the lighting of Baltimore, for it is recorded that George Wash-

ington dedicated a national park on the banks of the Kanawha River in West Virginia where there was a "burning spring." The first town to be lighted with natural gas was Fredonia, N. Y. That was in 1826, and in 1827, 250 domestic and commercial users in Titusville, Pa., received 4,000,000 cubic feet of natural gas a day through 2-inch lines from Newton well, 5 1/2 miles north of the town. Even though the pressure in the line depended on the pressure at the well, it is said to be the first "high pressure" gas line.

Bubbles in the Water

The lighting of Fredonia is of special interest to the natural gas industry, as was Baltimore to the manufactured gas field. The *Penny Magazine*, a London weekly, published on August 26, 1837, an article that appeared in *Brewster's Journal* (1830) about a "Village Lighted by Natural Gas." It said:

"The Village of Fredonia in the Western part of the State of New York presents this singular phenomenon. . . . While removing an old mill which stood partly over the stream in Fredonia, three years since, some bubbles were observed to break frequently from the water, and on trial were found to be inflammable. A company was formed, and a hole an inch and a half in diameter being bored through the rock, a soft fetid limestone, the gas left its natural channel and ascended through this. A gasometer was then constructed, with a small house for its protection, and pipes being laid, the gas is conveyed through the whole village. One hundred lights or less are fed from it, at an expense of one dollar and a half for each. The flame is large, but

not so strong or brilliant as that from gas in our cities; it is, however, in high favour with the inhabitants. The gasometer, I found on measurement, collected eighty-eight feet in twelve hours during the day, but the man who has charge of it told me that more might be procured with a larger apparatus. . . . The gas is carburetted hydrogen, and is supposed to come from beds of bituminous coal; the only rock visible, however, here, and to great extent on both sides along the Southern shore of Lake Erie, is fetid limestone."

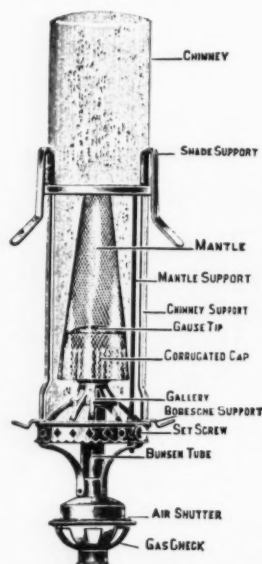
The well at Fredonia was 27 feet deep. At first gas was delivered through small logs; later, through a 3/4-inch lightweight lead pipe made by William Aaron Hart, a gunsmith. Hart's work was exceptionally important to the industry and to the gas lighting field. He was not only curious when investigating the bubbles that burned, but he was practical. He reasoned: Why not use this for the same purpose as manufactured gas?

Hart's first customer was the Fredonia Inn on the stage coach run between New York and Buffalo. Travellers stopped, marveled, and then carried the news of the lighting with them on their worldwide journeys. Today's gas utilities are taking advantage of similar promotional schemes. Near Fredonia, in the Iroquois Gas Corporation's territory, Motel 56 sits adjacent to the New York State Thruway. It has more than a dozen gas lights.

The *Fredonia Censor* of August 31, 1825, said "WHAT VILLAGE CAN COMPARE WITH FREDONIA? . . . two stores . . . two shops and one mill . . . every evening (are) lighted up with as brilliant gas lights as are to be found in any city in this or any other country. . . . The buildings which are now lighted have been literally thronged for several evenings past, and have been visited by several hundreds of strangers, who expressed their admiration at this invaluable discovery."

In 1865, Fredonia Gas Light & Water Works Company was formed—the first of its kind. Not only in this upstate village, but everywhere was gas proving popular. By 1875, the gas light era had arrived and the lamplighter was a familiar sight on American streets.

About this time, important events were taking place in Pittsburgh and Philadelphia, Pa., that were to have a far-reaching effect on the gas light industry. George Westinghouse started drilling for gas at his Pittsburgh home, Solitude. The date was December 29, 1883, and the following February he struck a sand-gas-bearing stratum. There was a "moderate" yield, but at 1500 feet, another vein was struck with a "good" yield. Westinghouse had a new diversion and began spending his evenings playing with schemes for drilling



SKETCH, AMERICAN GAS JOURNAL
WELSBACH'S INCANDESCENT BURNER

and improving prospecting. Slightly deeper "we struck such a volume of gas that it blew the tools out and ripped off the casing head with such a roar and racket that nobody could hear his own ears, within a block." The gas was ignited, and for weeks the neighborhood was lighted by a 100-foot-high "torch," much to the chagrin of the otherwise quiet residents of the area. The well was finally capped. Thus Westinghouse entered the natural gas business and a series of 28 patents related to it were filed. The Philadelphia Company (later the Equitable Gas Company) was created to handle problems of administration and executive control.

The natural gas industry came to Pittsburgh just in time, for industry was about to leave the area as being unprofitable. Rather than becoming a has-been, Pittsburgh flourished. The use of natural gas increased so greatly that Andrew Carnegie said that one natural gas company alone had 335 miles of pipe within the city and was supplying 250,000 cubic feet daily. He claimed that natural gas had supplanted 10,000 tons of coal a day.

By December 1884, the price of natural gas at Pittsburgh had been reduced

from 40 to 30 cents per Mcf, a further discount of 10 cents per Mcf being allowed for prompt payment. The *American Gas Journal* commented that this "ought to be cheap enough to satisfy anybody."

The October 1878 issue of the *Journal* said that the use of natural gas as the ideal fuel is growing and indicated that Harmony, Pa., runs practically the whole industry of the town with it—a situation for which today's utilities are striving.

As an indication of the growing trend, F. Victor Westermaier said (1922) before the New England Association of Gas Engineers, "Incandescent gas street lighting had its beginning in this country in 1896 with installation of 285 lamps; its growth for a period of 18 years was phenomenal, reaching its maximum in 1914 with a total of over 230,000 lamps. In 1922, 200,000 incandescent mantle lamps in approximately 180 towns remain. Total annual consumption of gas by these street lamps is approximately 3,000,000,000 cubic feet."

A prime contributor to this expansion was the perfection of the incandescent gas mantle. It increased the candle power of gas flames many times. It was invented in 1866 by Carl Auer von Welsbach at Von Bunson's laboratory at the

University of Heidelberg. The patent was granted in 1844, and the mantle was publicly announced in 1890. The following year a successful model was being marketed. By 1896, it was being used in street fixtures. Today's mantles are made in nearly the same form.

Mantles are impregnated with rare earth metals that glow brightly when heated by flame. The preparation used by Von Welsbach consisted of 1-percent cerium and 99-percent thorium, the former being responsible for the high luminous effect. Artificial fiber, cotton and ramie* thread are used to support the coating of rare metals; the cotton and ramie are hollow, while the artificial fiber is solid. Shrinkage noted in mantles is generally due to the cotton or ramie thread collapsing after burning. Before using, the mantles must be burned off, leaving the "ash" of the original make-up, the ash being the real light producer.

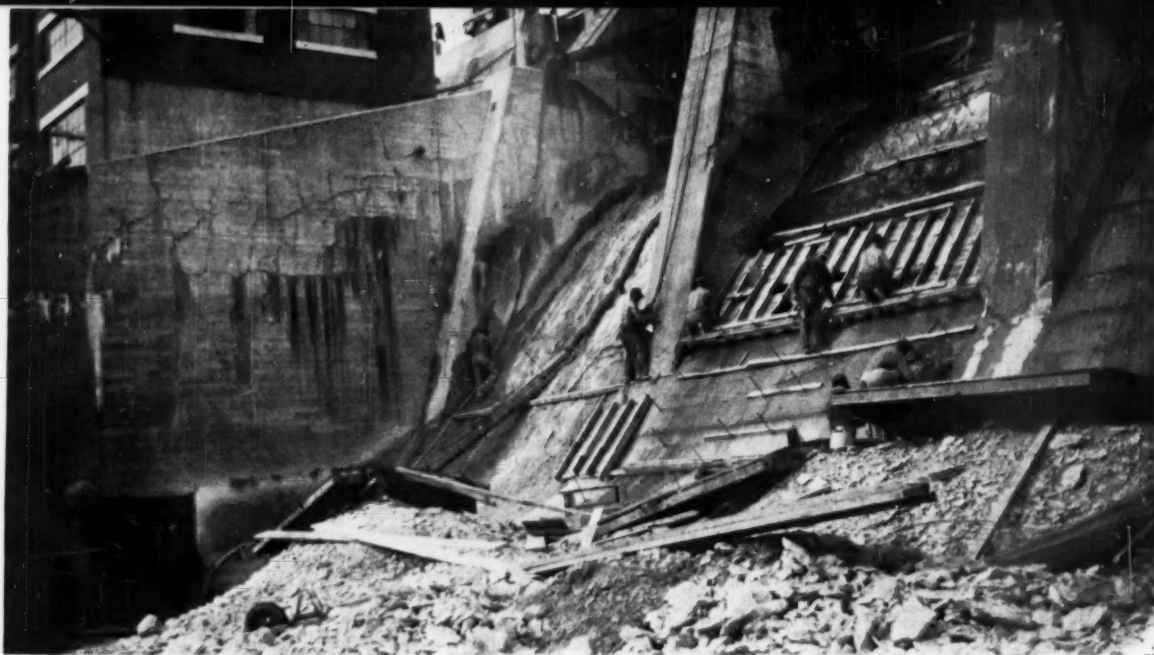
(To be continued)

* Obtained from a perennial plant with thick broad leaves, white and wooly on the underside. Native of Eastern Asia, it is commercially grown in China and Japan, and besides its use in mantles, is used in a spun form for fabrics resembling linens, nets and laces.



CONTEMPORARY A Riviera Gaslite by Arkla illuminates the front lawn of a home of today. Next month, "Com-

pressed Air Magazine" will discuss the revival of gas lights and the role gas utilities are playing in it.



BUBBLES PROTECT REFURBISHED DAM

Paul Ziemke

SNOW comes early in the Upper Peninsula of Michigan and soon stands high along the streets and several feet deep upon the countryside. The temperature works its way down to between 20° and 0° F and stays there, often dipping far lower. The lakes and rivers, never warm even in summer, freeze in late autumn and the ice thickness builds up as the cold winter months pass.

Forty-one years ago Mead Corporation, paper manufacturer, built a dam at Bonney Falls on the headwaters of the Escanaba River, a stream that runs diagonally across the eastern part of the Peninsula to drain into Lake Michigan. The builders counted on the reinforced concrete of the hydroelectric dam to resist the heavy ice that crowded the structure each winter and spring. The only

provision for combating the ice was a boiler and heating pipe arrangement that helped loosen the taintor gate guides in spring when melting was already underway. Through the years the combined effects of the bitter winter exposure, plus the ice and debris of spring and summer floods, deeply eroded the concrete. Engineers of the company carefully inspected the dam last year. They saw drastic repairs were needed, and also decided to install a system to alleviate the great stresses exerted by the ice on the forebays.

The first task was to refurbish the dam's concrete. Joiner Construction Company of nearby Iron Mountain,

Mich., proceeded to cut away the old eroded facing with paving breakers and moil points. Chipping of the surface and insertion of new reinforcing bars insured that the new mix would have a good face to cling to. At one point the air tools struck a weak, honeycombed section and the water shot out for 30 feet in a 3-inch stream. The same Ingersoll-Rand portable compressor that supplied the air for the I-R PB-8 Paving Breakers operated the grouting pump that closed the fissure. Forty-five bags of cement and 185 bags of sand were pressure grouted into the void to stop the leak. Air-operated vibrators helped settle the new concrete mix as it was

CONCRETE WORK The I-R PB-8 Paving Breaker at left bites into a section of honeycombed pea gravel. In the right picture, the gusher recedes after initially spewing water for about 30 feet.





GATES AND BUBBLES Workmen have raised the taintor gates at left for sandblasting and painting. Immediately below is a side view of the bubbling system that shows the hoses leading down from the header. At bottom is the I-R Axi-compressor that supplies 10-psig air to the lines.

poured. Other rehabilitation consisted of opening all the taintor gates, which control the water flow over the spillway, and sandblasting them. Then four coats of corrosion-resistant paint were applied.

The installation of an anti-ice system was next. After consultation, the company had decided to use a compressed air bubbling technique to keep ice from forming above the dam. An Ingersoll-Rand 450x8 Axi-compressor, a positive displacement axial-flow unit, was installed to supply air. The compressor is a 295-cfm machine that runs at 3450 rpm, powered by a 20-hp Allis-Chalmers motor. The unit is mounted on top of the dam, equidistant from each end. Compressed air at 10 psig runs to a 4-inch header line that spans the length of the structure. Every few feet along the header, $\frac{3}{4}$ -inch tees point downward; to these are connected hoses that extend down into the water 7 feet below the mean water level. Each hose's buoyancy is overcome with a 3-foot section of $\frac{3}{4}$ -inch metal pipe attached to the bottom of the hose. The pipe is sealed at its lower end except for a $\frac{3}{16}$ -inch orifice which emits air for bubbling.

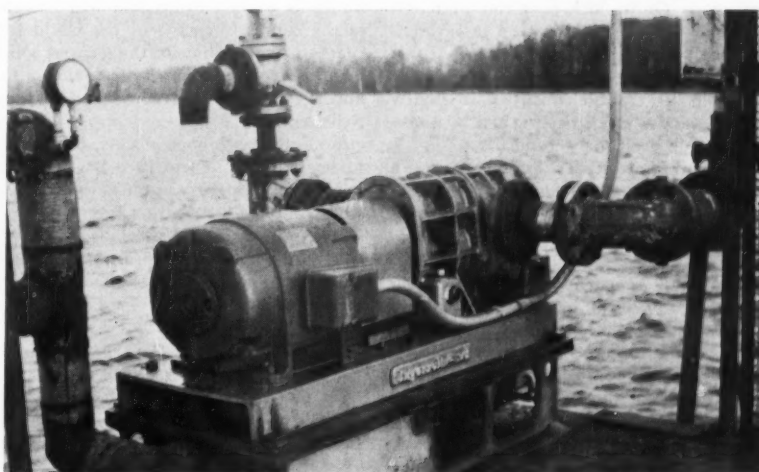
The bubbles agitate water in front of the dam and as the lower, warmer water is gurgled to the surface, it prevents freezing and the accompanying destructive icing conditions. Occasionally, when three conditions are right—the temperature of the water, and temperature and humidity of the air—a curious phenomenon occurs. Strange hollow globes of ice form, molding their shapes about the bubbles rising to the surface. The spheres remain intact for a few moments, sometimes temporarily sealing off the air, then the slightly warmer lower water apparently dissolves the ice.

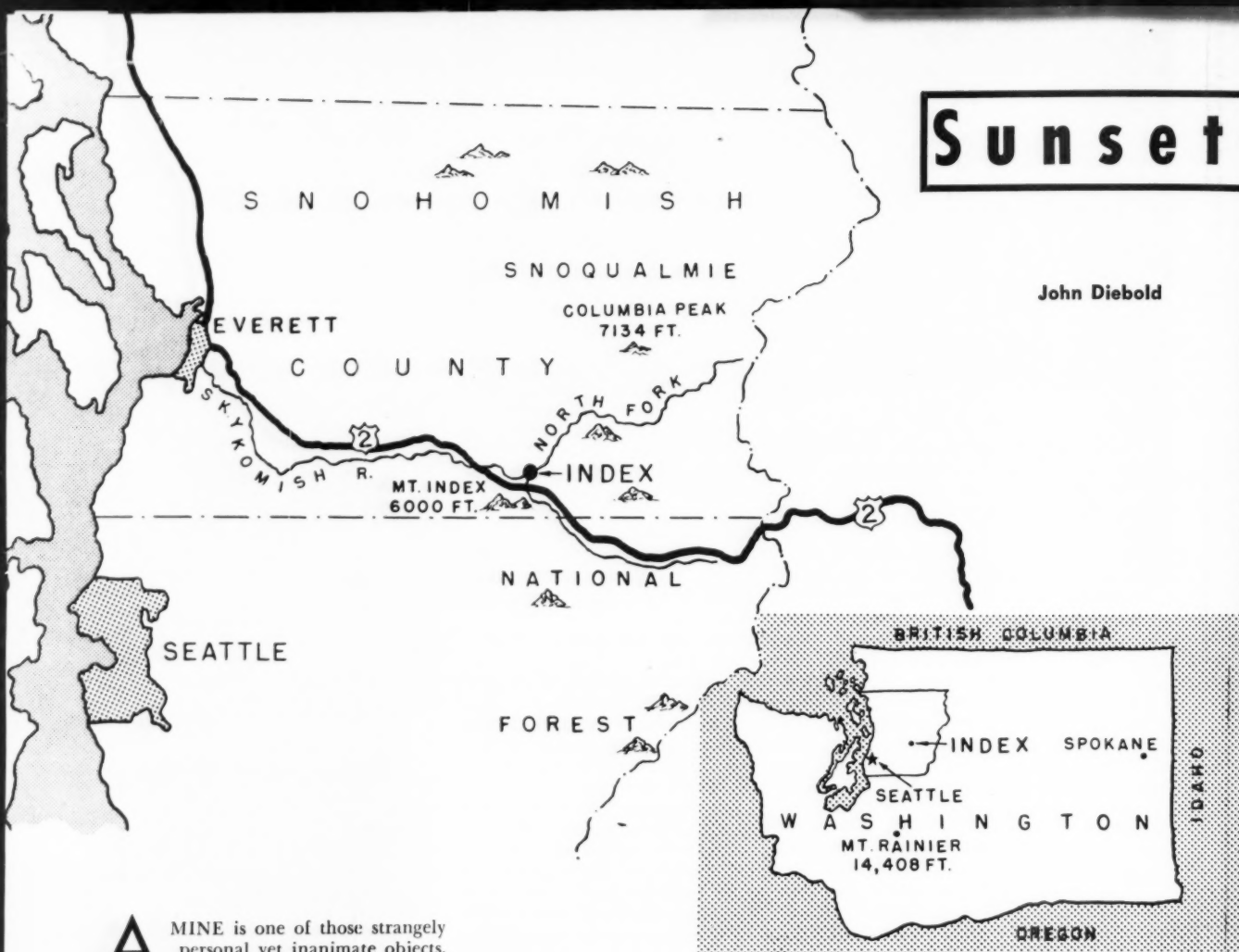
Engineers had anticipated that condensate in the air stream might freeze and foul the system. Three means were provided to prevent this. First, a condenser was installed below the compressor mounting to remove water before it had time to solidify. A spring-loaded safety valve atop the compressor was fitted with a $\frac{1}{2}$ -inch nipple, to blow down any water that the condenser gathered. Second, the 4-inch header line

was insulated for its entire length with weatherproof material to conserve heat. Third, a port was provided next to the pressure-gauge line at the compressor for the injection of alcohol antifreeze into the header line. The alcohol presumably would melt ice there, likely to form only during extremely cold weather. Use of this system has not yet been necessary.

First plans were to discard the original steam boiler and its heating lines to the taintor-gate guides, but this equipment has been retained. Sometimes a freak winter or early-spring thaw will send ice rushing down the river. When this happens every means available for keeping the gates open is welcomed.

The two turbines of the hydroelectric plant produced 5000 kw when the dam was first built. A series of exceptionally dry, cold winters has dried up much of the source lands above the dam, so it was decided to install one smaller wheel to more nearly match the stream flow. This reduced generating capacity to 4200 kw. The dam has S. Morgan Smith reaction-type water wheels, and the generating equipment, control boards, regulators and transformers are of General Electric make. The dam once supplied the needs of the paper mill plus those of the nearby city of Escanaba, but now the Mead Corporation requires the full output of two hydroplants on the river.





Sunset

John Diebold

A MINE is one of those strangely personal yet inanimate objects, such as a ship or locomotive, that can take on a nearly human personality. It would seem that during the constant rubbing of shoulders with man some of the human qualities become intermingled with the rock, timber and ore. As with a man, a mine's fortune may be good. It may spend its years productively or even richly, and thereby contribute to the betterment of a community. Or its luck may run foul and Dame Chance may frown on it, no matter the potential that lies hidden. If this is the case, the mine may stumble from trouble to trouble until it is finally beaten and then its passing can be a nostalgic and even sorry thing.

Washington State's Sunset Mine, a sporadic producer of copper since before the turn of the century, could be named as one of mining's unfortunates. It was not always so, of course. On June 8, 1899 the *Seattle Post Intelligencer* printed a headline to foretell the future of the Index, Wash., area where the Sunset Copper Mining Company had recently begun operations. Said the paper: "Index, the Mining Center That Will Yet Rival Butte."

The article told of other prospects in the region, then turned to describe Sun-

set Mine. "More activity is shown here than ever, preparations going forward for two purposes—shipping ore and sinking to the 500 foot level. A large station is being broken out in the drift for the operation of machinery for sinking. It is understood that a first class compressor plant is to be installed, in order to complete the work more expeditiously. The Sunset is a great mine, and will be one of the copper surprises of the world for years to come. Some of the clearest solid bornite ever seen comes from the mine and it is safe to say that the whole lead will average 18 percent copper. They expect, and with good reason, to be able to begin shipping ore in a few months. When they do, the country will know what Index has in Copper."

The mine's reserves were discovered on the Sunset Lode claim and the Black Bear claim on June 19, 1897. On July 8, the property was incorporated as the Sunset Mining Company, the deed was filed on August 2, and subsequently 1,000,000 shares of stock were issued at \$1 each. The mine was near the little town of Index, Wash., which had a population of about 300 persons. It is located about 50 miles northeast of Seattle.

At the turn of the century—as the newspaper story optimistically pointed out—Index was the center of considerable mining activity and Sunset was one of its greatest hopes. A fairly effective way to trace the history of such a property is by digging into its contemporary publications, such as the annually issued *Copper Handbook*, which has given varied and often intriguing information on mines in the industry.

The *Copper Handbook* of 1903 mentioned the Sunset Mine, listing the officers, quoting the capitalization at \$2,000,000 and reporting the shipment of 300 tons of 9-percent ore. The management had reported \$60,000 spent, the possession of thirteen claims of 20 acres each and 2000 feet of underground workings.

About 1905 a surface tram was built to accommodate the mines in the area and ran from Index on the Great Northern Railway, up the north fork of the Skykomish River to Trout Creek, a distance of nearly 5 miles. From the mouth of Trout Creek a gravity surface tram extended up the mountain for 1300 feet, connecting with another surface tram which extended another mile to the Sun-

Mine's Sad Story

set Mine. Ore from the mine passed over the circuitous network to Index, and was then transferred to the railroad for shipment to the smelters at Tacoma or Everett, Wash.

In that year there was already given a strong hint of hard times to come. A summary of the company's position made in 1905 outlined the Sunset Copper Mining Company as follows: "Office, Colvin Building, Glen Falls, New York. Organized 1897, capitalization \$3,000,000, par \$1.00. Thomas Garrigues, receiver, was discharged October 1904 on payment of mine's debts, about \$5,000."

Through 1907 the report on the company was about the same. Then a succinct report of 1908 notes "... another new management. Conflicting claims regarding acreage and ore riches, equipment now—shops, bunk houses, sawmill, waterpower said to have been developed ... neither company nor property is regarded with especial favor."

Conditions apparently worsened. The *Copper Handbook* for 1910-11 had graphic and terse comments about the Sunset Mine: "... dead." "... a bad egg." "... Property was sold by a receiver on March 30, 1909 to Frank L. Bell and W. W. Black for \$40,000.00, formerly at Index, Snohomish County, Washington." After this adversity Sunset Mine was idle for some years. At the time of the closure the mine had considerable equipment, acquired over its years of erratic operation. Among the equipment were two Ingersoll-Rand compressors which were probably purchased in 1899; numerous air tools; an extensive hydraulic power system that drove a sawmill and a direct-current generator; hoisting gear; considerable narrow-gauge track; and a few mine cars and the surface tramway described.

After a few years at rest the mine was sold to one E. A. Sims who put in a mill and started operations against a rising copper market. Mining activity was brisk between 1916 and 1920. The *Mines Handbook* and *Copper Handbook* for 1920—the publication had changed its name—said this about Sunset: "Property: The Sunset Mine, near Index, Snohomish Country on the Great Northern Railroad has a considerable tonnage of low-grade ore that can be treated profitably in the 150-ton mill built in 1917. Developed by a 1000 foot tunnel ... The mine, idle for several months, was unwatered in June 1919, and operations at the mine and mill resumed with a small force."

The facility was now well equipped

with crusher, ball mill, table classifiers and flotation units. The hydraulic system was enlarged when the mill was built; a 30-inch wood-stave water pipeline running from a height of about 200 feet served all the power requirements. The mine and mill operated for 10 months of 1920, closed down again, then reopened in 1923.

In April of that year the future of Sunset appeared to change somewhat. The copper market was relatively steady and it appeared that the newspaper prophet of 1899, who had forecast the bright future for Index, might have read his crystal ball correctly. The output from the mine in the succeeding years is given in this table:

1923	670,000 pounds
1924	850,000
1925	1,114,000
1926	1,287,000
1927	1,642,000
1928	1,078,000
1929	1,200,000

At this point Sunset mine was the largest copper producer in the State of Washington and owned 35 claims. The *Mine's Handbook* of 1931 states that "... the ore occurs in shoots or chimneys in the veins and is about 1/2 chalcopryite bearing and 1/2 bornite bearing. The Sunset is 16 feet wide and contains a considerable tonnage of low grade ore which is treated profitably. It is stoped 5 feet to 30 feet for a length of 2400 feet and a vertical distance of 500 feet. Most of the 1928 production came from the Sunset vein. The average as-

say value of the ore removed during 1927 was 2.41% copper; the average recovery about 91%.

"Development: by shafts and tunnels to a depth of 500 feet. The lower tunnel is over 1000 feet long. Company has been carrying on an aggressive development campaign for the past five years, for the most part following known ore bodies. During 1928 over 1100 feet of drifting was completed on the 500 foot level, over 1000 feet of which was in ore of commercial tenor."

The equipment now present included the faithful Ingersoll-Rand air compressors (these horizontal reciprocating units were driven by Pelton wheels); Ingersoll-Rand air drills; and a gasoline locomotive. The reduction plant had been increased to 190-tons daily capacity in 1927 and had a Blake jaw crusher, a gyratory crusher, ore sorting equipment, Traylor Rolls, Allis-Chalmers ball unit, Deister tables, two Dorr Classifiers, and Ziegler, K. and K., and Callow flotation units. The concentrates were shipped to the smelter at Tacoma, Wash. At peak production the company employed about 75 men, some of whom worked in the associated logging and sawmill operation.

For this period the *Mines Handbook* reported, "... average recovery per ton of ore for three years in which figures are available was about 46.7 pounds.

... Company is the only copper producer of any consequence in Washington, yielding about 99% of the state's production. Costs during 1927 were \$1.18 per ton for mining, including a \$0.25 development levy and \$0.75 per ton for concentrating." The handbook continued, "Figures for the year 1928

LONELY MOUNTAIN This is a view down Trout Creek Canyon from a point about a mile upstream from Sunset Mine. A few tailings from a new prospect are at left center.



show that for 27,729 tons mined, 1,666 tons of concentrates were shipped returning \$167,000.00. Net return for 1929 was \$233,400.00. Company is reported to contemplate spending \$500,000.00 during 1930 to increase its power and reduction facilities."

Probably Sunset Mine was closing down as these words were being written. In June 1934 the magazine *Northwest Mining* noted that the owner was "unwatering the lower workings for the purpose of examination and possible mining of a large block of known ore that will not require milling." Apparently this attempt was not profitable for the mine was leased in 1936 to the Sunset Syndicate Corporation, which dewatered and retimbered it. No production records have been found, but it is doubtful that this operation was profitable either, for the 1940 *Mines Register* has this to say about the Sunset Syndicate Corporation: "History: Incorporated May 1936, in Washington; acquired property of Sunset Copper Company under lease, reported, 1939 that lessees and associates were operating property under lien for unpaid wages."

Property records of Snohomish County are readily available back to 1938. In them can be found the sad final chapter of Sunset Mine's history. Against the property were filed liens on behalf of workers, liens by the State of Washington's Department of Labor, mechanics' liens, and creditors liens. Finally on August 18, 1938 a foreclosure notice was posted against all the known names under which the Sunset Mine had operated.

It changed hands still twice again. In November 1941 it was sold to Edward J. Carlson as trustee for lien claimants for \$18,997.76. Then the mine was purchased in 1948 by C. V. Brennan of Seattle for a reported price of \$15,000. Brennan operated the property on a small scale in 1948 until Nature stepped in to close it down. A high wind dropped a number of trees on the mine works. They crushed the water pipeline and compressor building, disabling the mill which had been operated by water power since its beginning.

Grandby Consolidated Mining & Smelting Company did extensive drilling on an option agreement in 1954-55, spending about \$110,000, but the results of this exploration have not been published. Some logs have been sold off the property, which lies entirely within Washington State's Snoqualmie National Forest, but no further mining has been carried on. During its life, the Sunset produced about 250,000 tons of ore and the mine's production rate and prosperity closely followed the volatile copper market. Brennan, the current owner of the mine, has no plans for reopening it, and within the entire Index area, little or no mining is currently done. Logging is the main industry now.



WRECKED MINE Sunset Mine as it is today, its buildings crushed and its water-powered compressors stilled. A compressor and its Pelton wheel are seen in the bottom picture. The compressors shown here worked until 1948 when wind toppled the trees.



This and That

Air Hose Racks

An idea for users of large quantities of air hose has been developed by Dayton Industrial Products Company and Unistrut Corporation resulting in a rack that reduces warehouse space requirements by a reported 50 percent, with an equally impressive reduction in handling time. The new rack stores bulky industrial hose reels on individual axles in bays on an A-frame rack. The hose is stored pyramid-fashion, the racks rising 10 1/2 feet. As many as eight reels are located in each bay. Since each hose reel rests on an individual axle, hose may be unreeled without removing the spool from its position in the rack, a feature



that is said to have reduced handling time on orders by 30 minutes. One man using a lift truck can stack individual hose reels, lifting and removing units with special clasps attached to the fork-lift arms of the truck. Compartment width in each hose spool bay is 42 inches, designed to accommodate standard spools of 36-inch width on the extended axles. The illustration shows the A-frame rack stores in one of the Dayton Industrial's regional warehouses.

★ ★ ★

Who Can Miss?

Apparently oblivious to advances in nuclear weaponry, James C. Ramsey of Lincoln, N. M., has patented an arrow that promises satisfaction to even the worst of shots during the coming vacation season. His arrow carries a number of little arrows in its war head. The head is tubular, and the parasite missiles are out of sight

as the marksman aims. The bow is drawn, the arrow released. A chain and rubber band arrangement then dislodges the cover in flight. The small arrows are instantly airborne. Because they have relatively little air friction, according to the inventor, they move out of the main arrow's head and "provide a distinctly larger pattern of contact with the game or other target."

★ ★ ★

Literary Electronic Computer

Everywhere we turn, an electronic computer is being put into action—working out industrial design data, picking mates on television shows, or simply computing payroll records. Now, thanks to one of these devices, many years, much labor and considerable money has been saved in turning out a concordance of the poetry of the Victorian, Matthew Arnold. The flawlessly correct machine system of editing has replaced a process that was formerly involved and required the painstaking detailed research of many editors and technicians. The method used was established by Cornell University's late Professor Lane Cooper, whose monumental *Concordance to the Poems of William Wordsworth* required 67 people cutting and pasting and alphabetizing 211,000 slips of paper—and then they had to proofread the results. He cut out lines of printed text and pasted them on 3x5-inch papers, each bearing an index word written in the upper left-hand corner. Line numbers were penciled, and page numbers and poem titles were stamped, on the slips. A year elapsed before a publisher could be found, and another one before the huge volume reached print. Dr. Cooper's concordance remains however, one of the largest ever printed, and his method has remained as standard operating procedure to the present day.

The Arnold work just published by Cornell University Press contains 965 pages of print and an appendix, revealing the occurrences of 10,097 words of the poet's vocabulary and some 70,000 references. It was produced at a dazzling speed by using an IBM 704 Data Processing System under the general editorship of Stephen Maxfield Parrish.

To do the job, the lines of verse, with-

out punctuation, were punched on cards—a task that required only 69 key-punch operating hours. Line numbers were punched automatically by running through an IBM reproducer the deck of cards representing each poem along with a numbering deck on which the numbers from 1 to 999 had been punched in fixed locations. Page numbers were gang-punched on the same machine, and one title card was punched for each poem. Including the initial key-punching, some 149 hours were consumed. The 17,000-card deck was then fed into an IBM Card Reader, which transferred the data to magnetic tape—1 hour. Meanwhile, a program had been written instructing the electronic "brain" to search the tape and to index alphabetically every significant word on it, omitting 151 nonsignificant words previously stored in its "memory," by listing the entire line in which the word occurred together with identifying information. Reading at a rate of 15,000 characters per second, and making 42,000 logical decisions per second, the computer run took 38 hours, and the printing 10 hours. The IBM print, spaced into pages, was reproduced for publication by the offset process.

Using the same process, Cornell University Press, the country's oldest, is preparing concordances to the poems of Yeats, Ben Johnson and Blake. Perhaps one day the question of Shakespeare's authorship will be conclusively solved by the IBM test.

★ ★ ★

Going "Critical" In Plastic

A scale-model plastic hobby kit showing detailed construction of a nuclear reactor and its associated components is a product of Revell, Inc. The kit is a replica of a typical atomic electric generating station. It has complete interior and exterior details including the re-



actor, steam generator, pumps, turbine generator, transformers, circuit breakers, and transmission lines and tower. The kit is technically accurate and is similar to atomic power plants being built by Westinghouse for the Yankee Atomic Electric Company, Rowe, Mass., and for a Belgian utility group near Brussels.

Westinghouse and Revell teamed to produce the new kit to provide a spark for catching the imagination of young students who would assemble it. With the plastic reactor goes a booklet, *A New World of Atomic Power*, by Dr. William E. Shoupp, technical director of the Westinghouse atomic power department. Dr. Shoupp is shown here explaining the model to a seventh-grade student.

★ ★ ★

Keeping ICBM's On The Go

The story of tonnage liquid oxygen-nitrogen production began in early 1955 when technical achievements in other fields, realized well-ahead of schedule, made long-range rocketry an immediate and imperative factor in the American weapons structure. For this program, the U. S. Air Force initially required 600 tons of liquid oxygen and nitrogen per day along the West Coast where the missile test centers were located. This requirement turned out to be more than twice the capacity available from all the commercial plants west of the Rockies.

Because ICBM's travel in the rarified atmosphere of space, each missile must carry its own oxygen supply with which to burn fuel. The other major component of air, nitrogen, is conveniently inert and used in the program to safely purge lines and containers which will later hold or transport the highly reactive oxygen. Both oxygen and nitrogen are obtained from the air at very low temperatures. The air is then distilled into the two components.

At the time the USAF Air Research & Development Command marked its tenth anniversary in January, the millionth ton of liquid oxygen-nitrogen had

been produced for it by its five major liquid generating facilities. The five, which make 85 percent of the Air Force's total consumption, were designed, built and are operated by Air Products, Inc. The first plant, built in the Santa Susana mountains of Southern California, went on stream in mid-1956. Since then, Air Products operators have produced a total of 1,000,000 tons of liquid oxygen and nitrogen for the Air Force at five locations, including Cape Canaveral, Fla. It is the mainstay oxidizer for the Atlas, Redstone, Titan, Thor and Jupiter missiles.

★ ★ ★

Teflon 100 Enters The Plastic Scene

Du Pont is producing a new plastic, Teflon 100, which is expected to be widely used in the electronics and chemical processing industries. The FEP-fluorocarbon resin can be extruded or molded in thermoplastic processing equipment. It was developed as a supplement to Du Pont's present line of Teflon TFE-fluorocarbon resins, which must be processed in a manner similar to powdered metals. Like its TFE resin cousins, Teflon 100 is virtually immune to chemical attack, has excellent electrical insulating, "anti-stick," and frictional characteristics, and will not absorb moisture. Teflon 100 differs from the TFE resins in heat resistance. TFE resins are rated for continuous service at temperatures to 500° F and at higher temperatures for limited periods of time. The usual service ceiling for Teflon 100 is about 100° F less. Both materials resist cold to minus 450° F. Du Pont is said to have spent about \$19 million for research, development and operating

costs during the 8-year period prior to starting up a commercial plant for Teflon 100 at Parkersburg, W. Va. Some of the material's specific uses include jackets for coaxial and multiconductor cable, aircraft wiring, molded electronic components, laboratory tubing, and chemical equipment linings.

★ ★ ★

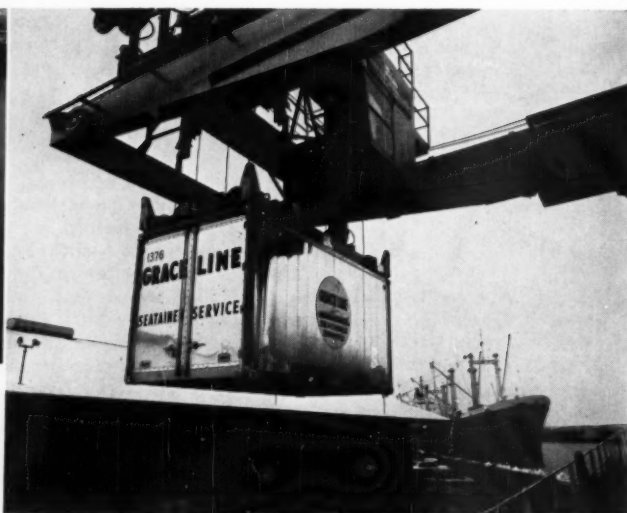
New Look For Research Ship's Decks

Vema, the 37-year-old, 3-masted oceanographic schooner belonging to Columbia University's Lamont Geological Observatory, has a new freshness in the form of a deck coating based on epoxy resins. She is now on her sixteenth expedition, this time to circumnavigate the Antarctic to gather scientific data which will contribute markedly to our knowledge of the earth. Lamont scientists believe that an examination of cores which will be taken from the ocean bottom as near the ice as possible, will indicate changes of climate going back millions of years and show that the weather in that area at one time was much different than it is now. The deck coating had to protect the steel deck from salt water corrosion, sun, and the extreme temperature changes encountered in sailing from the subfreezing zone of the Antarctic to the 130° F temperature likely to be encountered off Aden in the Red Sea. Further there was a need for a safe, nonskid surface for the decks since the *Vema's* size and the nature of her work in heavy seas make sure-footedness a necessity. Because the schooner would be away from its home berth for 9 months, it was also essential that a coating be laid that would withstand long periods without maintenance;

SEATAINERS GO TO SEA



Grace Line's "Santa Eliana" (above) and "Santa Leonora" have brought all-container service to U.S. foreign trade. On weekly runs to South America, the ships each carry 476 Seatainers, like the one at right. The 17x8x8-foot packets hold 18 long tons, and by cutting costly loading and unloading periods, allow for more time carrying cargos.



C Compressed Air Oddities

IN 1906 a pneumatic baseball was invented. It had a hollow core filled with air under pressure.

AROUND 1908 glacier ice in the Alps was drilled with air-operated drills and extracted in blocks in the same manner as rock is quarried. It was delivered to Lyons, France, and several other cities. It was preferred to other ice because it was harder and lasted longer.

THE so-called "air towel," which is an electric blower often found in rest rooms of public places, came into being as a result of agitation against the roller or common towel as a menace to public health. Massachusetts, Ohio and Michigan banned the roller towel first and were followed soon by 30 other states. The first replacement was the paper towel, but this required an attendant to replenish the supply of clean towels periodically and remove soiled ones.

To overcome these difficulties, J. M. Ward, superintendent of the District Building in Washington, D.C., invented

the air towel in 1914. Its blower forces air through an electric heater and then out of an opening under which the hands are held for drying. Modern versions have an electric eye (photoelectric cell) attachment that starts the blower when the hands are held in drying position and stops it when they are removed.

JOHAN DOS PASSOS, novelist, essayist and poet, was last year revealed as co-inventor of a compressed air gun that blows bubbles. It resulted from some experiments in his kitchen while he was conferring with a Hollywood writer and a New York lawyer regarding the making of his novel, *U.S.A.*, into a motion picture. It started when the visitors decided that the author's small daughter, Lucy, was working too hard producing bubbles in the old-fashioned way. The bubble gun has a hollow rubber handle, a barrel and a blunderbuss muzzle ending in a ring. When the ring is dipped into soapy water, a film forms across it. A squeeze on the handle sends a blast of air against the film, discharging a stream of up to six bubbles.

the relatively small staff—a crew of eighteen and a scientific team of about twelve—has too many duties to permit extensive maintenance operations at sea. The epoxy coating applied was manufactured by Burmar Chemical Corporation from Bakelite epoxy resins produced by Union Carbide Plastics Company, Division of Union Carbide Corporation. More than 600 gallons of the compound were used in coating the main deck, the deck-house roof, bridge, battery room and other storage compartments of the 202-foot vessel. In most cases, the coating was troweled on to a thickness of $\frac{3}{32}$ inch. A small amount was brush-coated to a 10-mil thickness.

★ ★ ★

Potable Water Cocktails

The problem of converting sea water into fresh is "as old as steamships," according to a Southern California Edison Company official. It has always been a low-efficiency, high-cost proposition, but the company is trying to find a way to reduce costs. It has devised a pilot conversion plant that went into operation early this year at Mandalay Beach, Calif. During the ceremonies putting the converter on

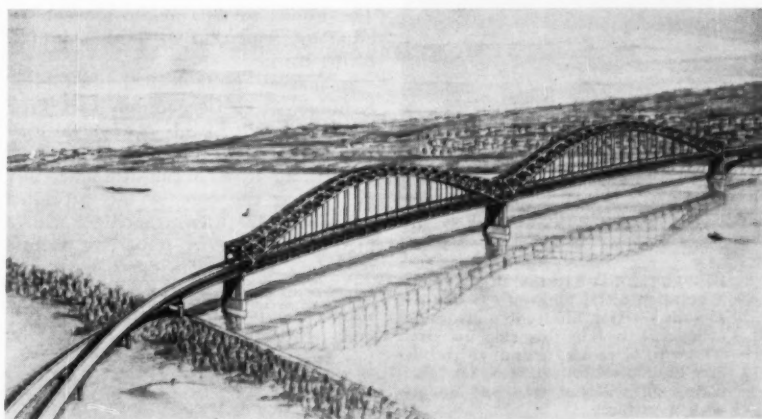
stream, cocktails of the fresh water were served; and "it tasted like water from home taps, except that it is, perhaps, a bit flatter." Although the unit is an experimental one, it is thought to be the world's largest, turning out 70 gallons of fresh water per minute. The plant utilizes 900 gallons of ocean water a minute, operating on the low-temperature distillation principle. The plant functions on spent steam from the adjacent steam electric plant. The 26-stage evaporator, built by Cleaver-Brooks, Inc., Waukesha,

Wis., consists chiefly of two 6-foot-diameter steel components, 70 and 25 feet long. Brine flowing into the converter is steam-heated to 175° F, passing through the 26 stages, each of which is under a vacuum. Flashing takes place in each stage as pressure is lowered, the resulting steam rising to the top of the components and condensing into distilled water on brass tubes. This pure water is siphoned from the plant in one direction; residue brine is returned to the sea. The plant is expected to act as a forerunner to saline conversion facilities with capacities of 5,000,000 to 10,000,000 gallons a day.

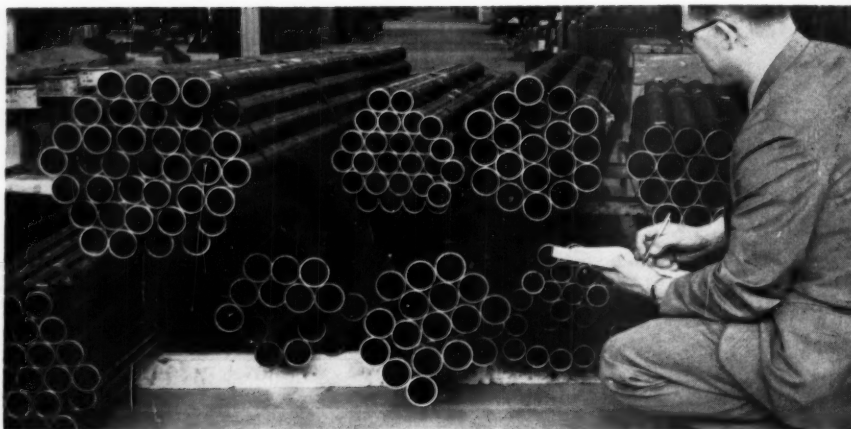
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Unique Bridge To Span Ohio River

A 1600-foot tandem, tied-arch, double-deck bridge will be built over the Ohio River near Louisville, Ky., to link with Indiana. When finished, the structure will be the only one of its kind in the United States, and will require fabrication methods used only once before in the history of bridge building—for the cantilever truss structure in the Carquinez Strait in California. The steel superstructure of the long Kentucky-Indiana link will be fabricated in Detroit, Mich., and shipped to the site. It will consist of two 800-foot spans, each double-decked. Each deck will carry a 42-foot-wide, triple-lane road with safety walks at each side. When completed sometime in late 1961, the structure will contain 15,000,000 pounds of fabricated structural steel, 1,250,000 pounds of reinforcing steel and 8000 feet of aluminum railing. A contract of \$5.4 million has been awarded to the Structural Steel Division of The R. C. Mahon Company of Detroit for the bridge and construction of the bridge's \$1.5 million substructure is already underway. Ninety percent of the large structure's nearly \$15 million cost will be paid by the federal government and each of the states concerned will pay 5 percent. A drawing of the bridge is shown below.



READY TUBING Tubing supplied by Republic Steel Corporation is made of flat-rolled steel that has been inspected and selected to insure its suitability for pneumatic and hydraulic cylinders. It is waiting for processing at Tomkins-Johnson Company.



Behind An Air Cylinder

"Special Smooth" Welded Tubing Simplifies Cylinder Production

THE OMNIPRESENT pneumatic cylinder is sometimes called "the workhorse of automation." It is only when one fails to perform as it should that a glimpse is gained of the precise manufacturing steps required to produce cylinders of near-perfect roundness and concentricity, and having the smooth-wall characteristics needed. To do all of these things in making a product line that meets quality specifications and yet remains competitive in price is a problem not unique to the wide variety of air cylinder makers.

Tomkins-Johnson Company uses a Special Smooth inside diameter Republic welded steel tubing in most of its "stock-size" cylinders. The advantages are many according to the firm. The tubing as-received requires but five passes with a honing machine and minor working with polishing paper to bring it within the 6- to 8-microinch finish required. The tubing saves Tomkins-Johnson an estimated 5 percent in finish manufacturing costs.

In making the close-tolerance tubing, Republic Steel Corporation uses Electronite flat-rolled steel. The metal used is single strand, rim steel. Any fine-grained impurities in rim steel inherently fall within the core of the flat-rolled product. This leaves the edges with a high degree of purity, important because the edges are fused together in an electrical-resistance self-weld. By using the proper combination of speed, pressure and temperature, neither welding rod nor flux need be introduced.

After forming, the welded tube moves in a continuous processing cycle through

a controlled atmosphere normalizing furnace. This stage assures a uniform ductile tube for subsequent drawing operations and makes the weld structure identical to the structure of the rest of the tubing.

Carefully inspected and selected for air and hydraulic cylinder use, it is tested electronically on a Farrowtest unit for possible defects rather than by the more conventional high-pressure hydrostatic testing. This locates incipient flaws that escape standard limit-pressure examination.



QUICK PROCESSING A vertical honing machine is ready to make a pass at a length of steel tubing which will become a cylinder. A few passes are enough, and these are only for smoothing, not for increasing the diameter.



INSPECTION Light reflected from a polished metal table brings out the smooth interior finish of a hydraulic cylinder barrel in this close-up view. There is, of course, a limit to the degree of smoothness obtained, for lubricating oil will not stay put on too slick a surface.

EDITORIAL

Sales Engineering

SEVERAL months ago we reported the awards presented by a group of construction men on the West Coast. The coveted Golden Beavers were handed to men noted for their service to the industry and to the people working in it.

When such an article is presented we almost expect that the majority of construction men will look at the article and be interested in the awards. This we found to be so, for about 85 percent of our readers in that field read the story. What puzzled us was the indication from a readers' study that more than half the readers in other fields also looked at the article and were interested in it. There is an old axiom in the editing and publishing field that names make news and this possibly accounts for some of the interest.

Then, a few weeks ago, we were talking with a group of friends in a manufacturing industry and the subject came up. The conversation helps explain some of the interest and was a bit surprising. The gist of the whole thing is that while many industries award and recog-

nize service in some fashion, the Beavers are almost unique in honoring a man in a "supply" category.

"I wonder," said one of these men, "how many times it is that behind a successful job, whether it's a construction project, a new plant, a process line or, in my field, an assembly line, stands a good sales engineer that must have known not only his product well, but knew quite a bit about the over-all job too." "So many times, too," said another, "the guy that sold the job and did a lot of hard work sits back and lets somebody else get the 'well-done's.'"

The general consensus was that most engineering salesmen, because of their thorough training and wide experience in the field, are an invaluable addition to the engineering staffs of companies in all fields. One man summed it up well: "There should be more awards like that because so many sales engineers give so much more time than they really have to simply because they are interested in us and really want to be of service."

Free Air

WHEN the soon-to-be vacationing American motorist services his car for the family's long-planned excursion, about the last word of instruction to the service attendant will likely be "and check the air in the tires."

It has often been said that the most frequent contact that the layman has with compressed air is in the tires on his car. It's also a little realized fact that the installed compressor horsepower of the automotive service industry is greater in aggregate than that of many another industry where compressed air is an integral part of a process. There are now some 200,000 service stations meeting motorists' needs. With the current U. S. automobile and truck population in the neighborhood of 60 million, that adds up to a lot of service.

"Free air" was a common sign on early gasolinestations. The popularity of establishments offering the use of their compressor gratis can be fully appreciated only by those old enough

to have wielded a hand pump. Since 1907, when the first gas station made its appearance, the air that was once almost solely used for tire inflation is now put to work in a variety of ways. Besides the almost universal air-over-oil hydraulic lift and grease guns, spark plugs are cleaned with its aid, wheels changed and rotated, mufflers and shock absorbers replaced, undercoating applied, general repair work undertaken and it is even used in some types of automatic car washing equipment. With all of these growing air usages in the automotive shop, it's small wonder that the larger service stations sometimes consider the tire inflation hose almost insignificant.

Nevertheless, it is true that this is a nation on wheels and of the 60 million vehicles, the number that don't ride on pneumatic tires is insignificant. We'd like to point out that the air in our tires is just another example of our dependence on compressors and compressed air.

Supplying Brake Fluid to Autos

Edward G. Dickson

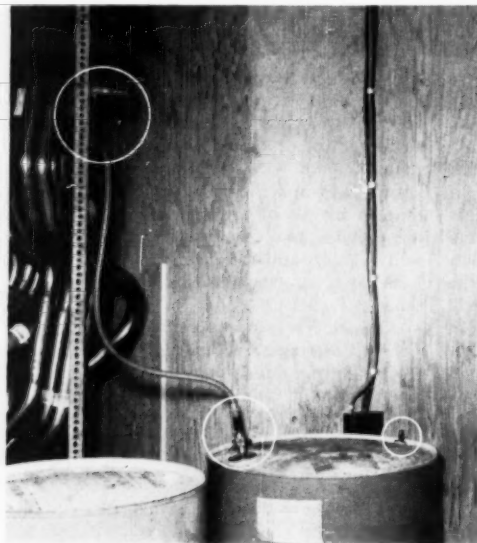
A COMPRESSED air feed system makes brake fluid instantly available to mechanics at Sta-Rite Muffler & Brake Station, Miami, Fla., enabling them to do their work with greater ease and efficiency.

The system, planned and installed by shop personnel, pipes brake fluid from a drum in the stockroom some 60 feet to the brake service area of the shop.

Here, with a long length of rubber tubing and a quick-coupling connection, a mechanic always has brake fluid available for flushing or bleeding on the job he is handling.

Shop-made fittings for the brake-fluid drum in the stockroom are the key to the transfer system. These have been set in threaded filler and drain plugs. In one of the plugs is a tire valve, through which compressed air is put into the drum. Pressure is kept at about 15

psig. In the other plug is a fitting with rubber tubing extending inside to the bottom of the drum. Above the supply barrel, the tubing connects with $\frac{1}{4}$ -inch galvanized pipe through a cut-off valve. The pipe, in turn, runs to the ceiling and across the shop to the brake service area where the system ends with a length of easily maneuvered rubber tubing. The drum is charged with air only about once a week. (A drum of brake fluid lasts the shop 2 or 3 weeks.)



TRANSFER PIPING In the left photo the major fittings are circled. On the drum the left fitting is the fluid outlet, the right one, the tire-valve air inlet. Above, tubing runs to pipe joint and on-off valve.



Reducing Foundry Costs

SAND WIPER RAMMERS are designed to cut foundry costs, improve quality of work, and speed up over-all operations. These air-powered rammers, manufactured by Ingersoll-Rand Company, have a specially designed front seal of neoprene-felt that wipes the surface of the cromeplated piston rod completely clean. This prevents entrance of any sand or abrasive material into the bore of the guide or the barrel. A leather seal ring makes an air-tight seal around the rod, providing positive sealing with minimum friction. Air pressure against the face of the seal holds it tightly against the rod. The unit's crome-plated piston rides smoothly in the honed barrel, reducing frictional losses. The complete

packing unit is self adjusting to compensate for wear and keep power and speed at a maximum. Advantages over earlier models, as listed by the manufacturer, include: a consistently uniform blow that produces required sand density faster; twice as many blows per minute with the same amount of air consumption; and a better quality mold with less ramming at increased speeds. As for dimensions, the Size 341 and 441 are $52\frac{3}{4}$ and $50\frac{7}{8}$ inches long, respectively, including butts. The 241 is $52\frac{3}{4}$ inches long, while bench-type versions of the same tool are $25\frac{1}{2}$ or $23\frac{1}{4}$ inch long with pistol grip handle or lever throttle. Weights range from 18 to $47\frac{1}{8}$ pounds. Barrel bores are $1\frac{5}{16}$, $1\frac{3}{8}$ and 2 inches.



"Is that one of our boys?"

Aiding Truck and Trailer Unloading

A TRUCK DRIVER arriving at loading docks is often faced with the annoying task of stopping his vehicle to open the rear doors, then crawling back into the cab to move the truck to final position. He must do this because the doors would be obstructed by the loading ramp if he tried to open them when snug against the dock's bumper.

An air-operated dockboard, called the Aero-Board, has been devised to eliminate this problem. The trailer or truck can be backed in with doors closed, and once against the dock, the doors can be opened without meeting a ramp. Up to this point the Aero-Board, manufactured by the Freightliner Corporation, Portland, Ore., is held aloft by its air-powered hydraulic cylinder. When an air valve is pushed from the "up" to the "down" position, the permanently installed dockboard moves from the vertical to the horizontal, ready for use. The truck is loaded or unloaded and then the board is raised, ready for the next vehicle to move in.

The Aero-Board's parts can be seen in the accompanying drawing and photographs. Its steel safety tread board is 57 inches long and 60 inches wide, painted aluminum. It is permanently affixed to the dock by a piano hinge and raised and lowered by a hydraulic cylinder attached below. A second model is built for docks that do not have bumpers. This flush-dock model has its own fabricated steel bumper.

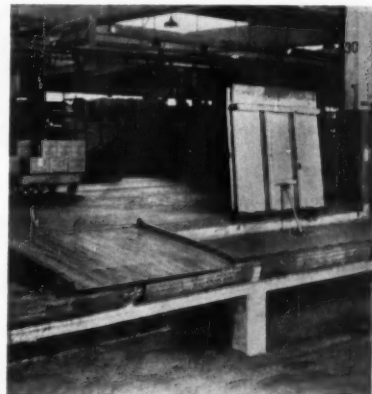
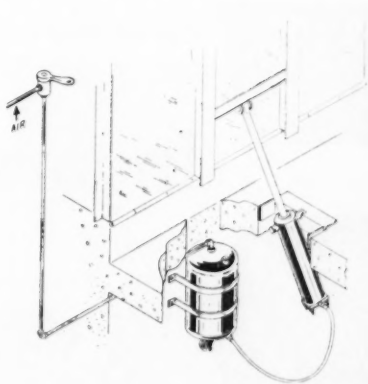
Rated capacity is 10,500 pounds wheel load or a 4000-pound-capacity lift truck. The hydraulic fluid tank is mounted near the cylinder and air controls are located at hand level on the dock. Air for a unit is held in a receiver tank centrally located in the terminal and lines run from the central location to each hydraulic unit. Up to 24 of the boards can be activated by one receiver. Small single- or 2-stage compressors normally supply the air.

The main advantage of the air-operated device is that it speeds loading and unloading of trucks, which results in dollar savings in the labor time spent on each. It also saves storage space because it is quickly folded out of the way when not in use, and its permanent position prevents it from slipping during loading. Further, the air-powered device is much more easily handled than a manually moved ramp, and its use of compressed air means that no electrical outlets must be at hand.

SAVING WITH AIR POWER APPLICATIONS

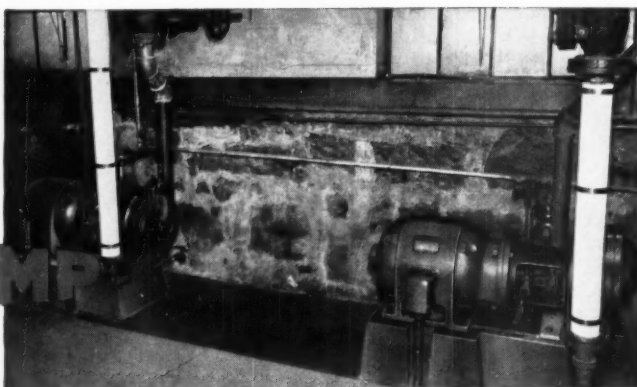


LOWERING This Aero-Board is being moved down to rest on the bumper so that the packing cases in the background can be rolled into the truck at left. The air-powered device allows the truck doors to be opened after final positioning of the vehicle, and makes loading faster and easier.



DETAILS The cutaway drawing at left shows how the Aero-Board is installed. Visible are the hydraulic cylinder that raises the metal tread board, the hydraulic liquid reservoir, and the air supply line and lever control. In the right picture are two of the Aero-Boards, one down ready for use and the other raised.

Two 30 horsepower multi-stage
Motorpumps on boiler feed service.



MOTORPUMP

... the pump

that always stays on stream

Where your process or production depends on movement of liquids, you can rely on Ingersoll-Rand Motorpumps for continuous, efficient pumping. Motorpumps are built for rugged service and their simplicity of design allows for easier, faster maintenance if required.

These close-coupled units range in sizes from $\frac{1}{4}$ through 75 horsepower . . . capacities to 3200 gallons per minute . . . heads to 650 feet. They're available with threaded or flanged suction and discharge connection and come in single, two or four stage models.

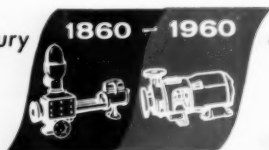
To learn how Motorpumps can solve your specific pumping problems, call on the specialist at your nearby I-R branch—or write direct. We'll design a unit for your specific applications if we can't meet requirements from our many standard models.

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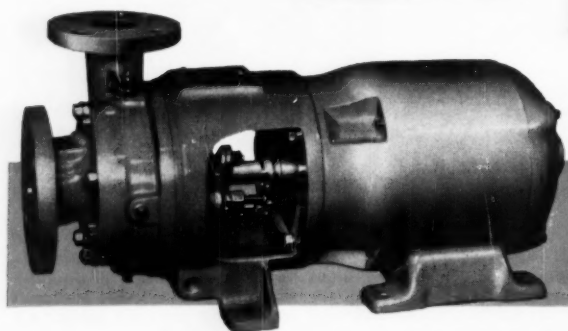
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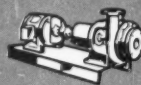
OTHER I-R PUMPS AVAILABLE



Horizontally
Split Pumps



Self Priming
Pumps



Cradle Mounted
Pumps

AERICAN Hoist & Derrick Company has released a 20-page catalog on the 200 Series Crawler Excavator/Crane. The catalog, No. 720-CG-3, describes and illustrates features aiding both owners and operators, including a positive pressure backhoe and a positive rope-crowd shovel attachment. The 200 Series machine's versatility is shown on many different jobs, such as crane, magnet, clamshell, dragline, shovel and backhoe projects. Copies of the publication are available from distributors or directly from the company. *American Hoist & Derrick Company*, 63 S. Robert, St. Paul 7, Minn.

A GUIDE has been issued that lists the ability of metals, plastics and synthetic rubbers used in the manufacture of Flo-Ball Valves to resist the corrosive effects of 390 industrial fluids. A table permits rapid estimate of the effect of the fluids on selected materials of construction. The metals are aluminum, carbon steel, semi-steel, and 316 stainless steel; the synthetic rubbers are Buna N, neoprene, and Viton A; the plastics are Teflon, nylon and Kel-F. An introduction provides a cross section of the Flo-Ball Valve and the chemical composition of the metals used in its construction. The physical characteristics and temperature range of the plastics and synthetic rubbers are also provided. Requests for the Corrosion Guide should be on company letterhead. *Hydromatics, Inc.*, 70 Okner Parkway, Livingston, N. J.

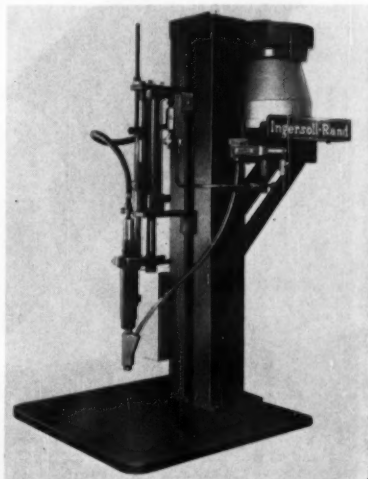
COMPRESSED AIR DRYERS in three new sizes have been added to the line of Van-Air Dryers. They have capacities of 10,000-, 11,000- and 11,500-cfm, at 100-

psig pressure. This brings the total line to 33 sizes, with ranges for drying any volume of compressed air from all the air for a plant down to minimal air for small operations. Adaptable to any air system, the drying process is designed to intercept residual water-vapor along with microscopic abrasives and potent acid fumes which elude aftercooler, receiver and filters. It goes without saying that capturing these corrosive by-products of air compression prolongs the life and accuracy of pneumatic equipment and prevents freezing air lines. Dryers are automatic—require no regeneration, heat or power. *Moisture Control*, a 16-page brochure, explains the method in detail. It is available without cost. *Van Products Company*, 5729 Swanville Road, Erie, Pa.

THE Atomic Energy Commission has published a 4-page pamphlet, *USAEC Patents Available for Licensing (TID-4557—first revision)*. The pamphlet briefly describes the scope of the Commission's patent portfolio, the availability of patent abstracts, procedures for applying for patent licenses, procedure for applications for royalty, and

the availability of patents. It is obtainable without charge. *U. S. Atomic Energy Commission*, Technical Information Service Extension, P. O. Box 62, Oak Ridge, Tenn.

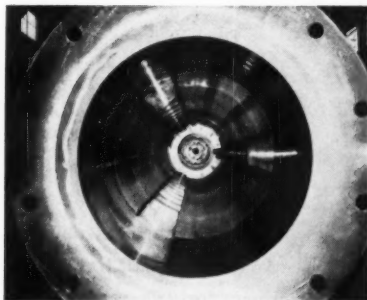
SCREW PATTERNS can be quickly changed on the new, appropriately named R-A-F (Rapid Automatic Fastening) Screw Driver. The job is accomplished simply by loosening and tightening two bolts on each powerhead. The R-A-F drives virtually any number of screws in practically any production pattern. Meeting the demands of the fast-



est assembly lines, the fixture is also reported to run screws in 1 second. Three power ranges are provided by three different Multi-Vane Air Motors for precise, predetermined torque control. In each power range, the motors run to stall, driving screws to a preset, accurate torque. Powerheads can be located as close as 2 inches, center-to-center, and can be added or removed easily. Every common screw type can be handled by the standard R-A-F; special hard-to-feed screws can be used with minor adaptations in many cases.

Standard vibratory or barrel feeders are used, each feeder handling as many as four powerheads. As for its dimen-

BIG BERTHA FOR BISCUITS



This 16-inch is not a naval gun but a 40-foot food mixing machine called a Ko-Kneader, built by the Chemical Machinery Division of Baker Perkins Inc., Saginaw, Mich. Its "rifling"—visible in the left picture—is actually rows of stainless steel teeth which will aid the action of a huge mixing screw placed inside. The right picture shows the barrel's two halves and the intricate screw overhead; breaking apart of the barrel aids cleaning. In operation, the behemoth can process about 10,000 pounds of materials per hour.

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safest and
surest way to ...

a Leakproof
Hose
Connection

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Here is the pair
for clean, dry
air ...

**JOHNSON
AFTERCOOLER**

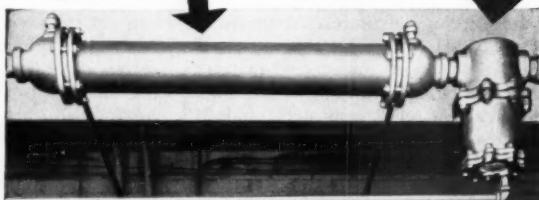
Used where moisture is vaporized by the heat of compression. Circulates cooling water around the line, condenses the oil and water vapor so Separator can remove them. Simple in design, highly efficient in performance.

SIZES
FOR ALL
NEEDS

**JOHNSON
SEPARATOR**

Removes more than 99% of all water, dirt and oil from compressed air or steam. Combines the two best principles of separation—first allows air to expand slightly, then changes flow direction with the "Thousand Baffles". The newest idea in separator design, with self-draining trap mechanism built right in.

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BULLETIN



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IRVINE, WARREN COUNTY, PENNSYLVANIA

sions, the unit is compact for production line installation. Column height measures only $4\frac{3}{8}$ inches. The standard base measures 24 inches square, but larger bases can be furnished for mounting larger fixtures. Throat depth ranges and powerhead strokes are widely variable. The throat depth ranges from $8\frac{5}{32}$ to 14 inches from center line of powerhead to column. This clearance allows ample room to handle a wide variety of jobs. Powerhead stroke is adjustable to 6 inches maximum. *Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.*

AN ESTIMATED 250-percent increase in service life, plus more complete soot removal, can result from the use of high-alloy, shell-molded nozzle heads in a new soot-blower design for stationary and marine high temperature boilers. The nozzle heads are used in long retractable soot blowers that are replacing fixed units for tube cleaning work. The nozzle is welded to the end of a lance which sprays jets of high-velocity air (or steam) through the nozzles. The lance simultaneously rotates and extends or retracts within the boilers. Because the jets release more mass at higher velocity, better cleaning is said to be accomplished with the long soot blower than with fixed units. When blowing is com-



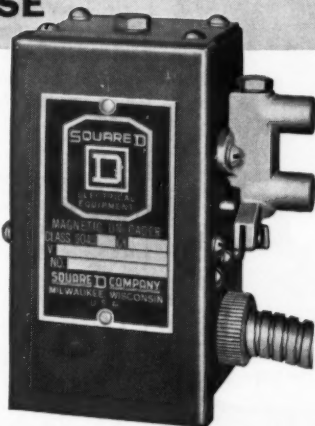
pleted, the lance and nozzle assembly are retracted from the corrosive heat zone into a protective sleeve in the boiler wall or roof. Cast from type HN (Alloy Casting Institute designation) heat-resistant alloy, nozzle heads must resist unusually severe operating conditions. Boilers may be fired with black liquor, waste heat, pulverized coal, stoker coal, Bunker C oil, or other fuel oils containing much destructive sulphur, sodium and vanadium pentoxide. Nozzle heads are exposed to flue gas

temperatures as high as 2300° F, radiant heat from burners, abrasive burner ash, plus some blowing medium—air or high-velocity steam at pressures from 100 to 600 psig and temperatures to 800° F. Two alloy nozzles are shown in the photograph. *Blaw-Knox Company, Copes-Vulcan Division, Erie, Pa.*

ALUMINUM foil is available with an adhesive coating that bonds it permanently to plastics, plywood and other wood products. Foil in this form, according to the manufacturer, promises to open broad new marketing possibilities for aluminum because of the improved properties it lends to other materials. When bonded integrally to wood or plastic products, the coated foil may serve as a moisture barrier, decorative element, a base for paint, a light reflector, a strengthening agent or disperser of heat. Specifically it is expected to be used in the manufacture of hard and soft plywood, furniture panels, wall coverings and plastic laminates. Bonding to other materials is accomplished under heat and pressure, usually in a hot press. The foil became feasible when Polymer Industries, Inc., created Dri-Line, a type of coating which anchors extremely well to any aluminum surface. This coating will chemically react with cellulose materials

SQUARE D Magnetic Unloaders ARE DEPENDABLE, EASY TO USE

- Dual-voltage coils simplify stocking and installation
- Minimum of moving parts reduces wear
- Condensation is blown into atmosphere—coil and other parts stay dry
- Operates at pressures up to 250 P.S.I.
- Available with 2-way, 3-way or slow-bleed valves for AC or DC operation



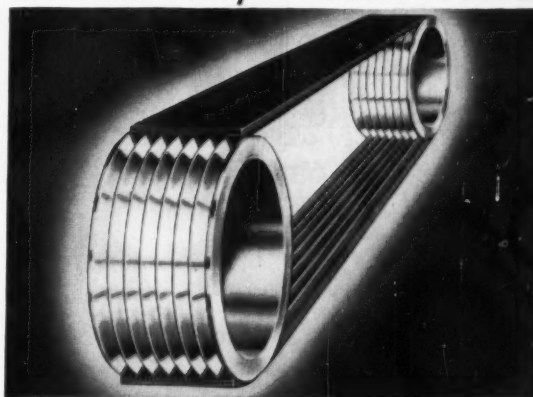
Write FOR DETAILS. Square D Company,
4041 North Richards Street, Milwaukee 12, Wis.



SQUARE D COMPANY

wherever electricity is distributed and controlled

CONVERT TO R/M POLY-V® DRIVE!



NO OTHER DRIVE DELIVERS AS MUCH POWER IN AS LITTLE SPACE!

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| <ul style="list-style-type: none"> • MORE POWER — LESS SPACE
... with Reliability • SINGLE UNIT DESIGN • ELIMINATES BELT "MATCHING" PROBLEMS • MAINTAINS GROOVE SHAPE • CONSTANT PITCH AND SPEED RATIOS | <ul style="list-style-type: none"> • LESS WEAR ON BELT AND SHEAVES • COOLER, SMOOTHER RUNNING • COMPLETE CONTACT-PRESSURE • TWO BELT CROSS SECTIONS MEET EVERY HEAVY DUTY POWER REQUIREMENT |
|--|---|

Poly-V is patented

Write For Bulletin M141

RM1019

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MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY





EASIEST WAY TO
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The Time-and
Job-Proven Method
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NEW PLAINLOCK COUPLINGS AND FITTINGS

For Low Cost Jointing of Plain End Pipe



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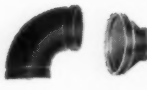
Rigid Couplings



Malleable Iron Fittings



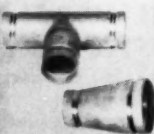
PVC Lined Fittings



Plastic Fittings



Aluminum Fittings



Stainless Steel Fittings



Vic-Groover Tools



Vic-Easy Tools



Plug Valves

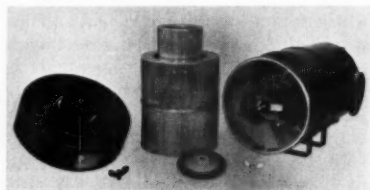
For complete information on any Victaulic product, write:

VICTAULIC COMPANY OF AMERICA

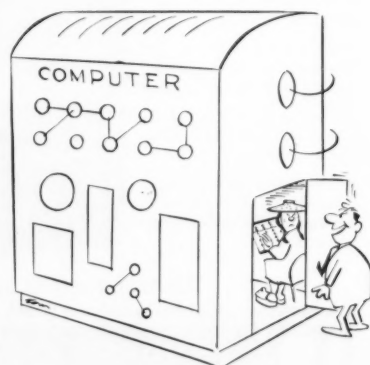
Dept. 62-5, P.O. Box 509, Elizabeth, N. J.

and with cured resins to form almost permanent bonds. The adhesive coating will not adhere to any substance, or itself, except under the specific conditions of pressure, heat, time and moisture. The foil will be available in gauges down to .001 and in widths to 50 inches, coated on one or both sides. *Aluminum Company of America*, 734 Alcoa Building, Pittsburgh 19, Pa.

TWO-STAGE air filters—two filter elements in a single housing, with each element independently sealed—for both heavy-duty automotive and industrial engines have been devised by Parolator Products, Inc. The dry-type filters were designed for more efficient engine protection where automotive and industrial equipment is continually operated under abnormally dusty conditions, such as in construction, mining, logging and sand, cement, or gravel hauling. Each unit embodies two separate elements. Both

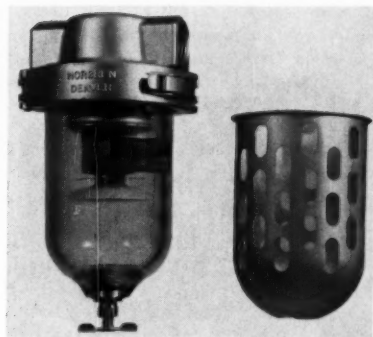


the first- and second-stage elements operate independently at a reported 99.8-percent efficiency at all engine speeds. The second-stage element's function is to provide continued engine protection in case the first stage, or working element, is damaged. The elements are made from a plastic impregnated cellulose with a new depth-type radial pleating for greater dirt holding capacity. The porosity of the filter media for both elements is the so-called "extra-fine" type. The filters are rated from 450- to 1150-cfm with an exceptionally low initial restriction. Extensive field testing has proved that the advantage of hav-



"Aha—just as I suspected."

ing a low initial restriction will provide element life anywhere from 600 to 2000 hours continuous use. Mounting straps, rain hoods, and outlet adapters have been designed and are available for installing the filters in the field. Servicing the 2-stage air filter does not require any special service program. The two elements, telescoped one into the other, are independently sealed in one housing permitting the first-stage element to be removed, cleaned or replaced without distributing the second-stage. *Puro-lator Products, Inc., Department 123, Rahway, N. J.*



REMOVING all the liquid present in compressed air over the full range of air-flow capacity of the air line is the feat of the Series 30 BE air line filters illustrated. Improved baffling makes it possible. A transparent bowl of strong plastic is an important design feature.

It has a high safety factor and great resistance to fatigue under cycling loads, it is reported. Furthermore, the bowl is larger than those used previously and has a larger quiet zone, holding 53 percent more liquid before emptying becomes necessary. The filter has been designed to be quickly and easily cleaned. No tools are needed and there are only four parts to handle. The Series 30 BE

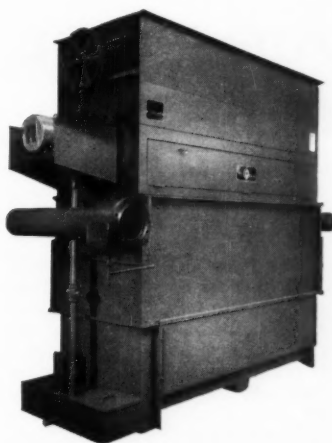
(and Series 30 BE-N, with a metal bowl for high-temperature and high-pressure applications) is available for use with pipe of $1/4$, $3/8$, and $1/2$ inch. A choice of four optional and interchangeable filter elements for removing the solid particles from compressed air may also be had. Unless otherwise specified, the filter is furnished with a 74-micron, 200 mesh, reinforced Monel wire screen. For removing smaller particles from compressed air, optional 64-, 25-, or 5-micron sintered metal filter elements are available. *C. A. Norgren Company, 3400 S. Elati Street, Englewood, Colo.*

THE ENGLISH volume of the pro-

How to get drier or cooler AIR or GASES at low cost

NIAGARA AERO AFTER COOLER cools a compressed gas, or air, below the temperature of the surrounding atmosphere, thus preventing the condensation of moisture in your lines. The gas will contain only half of the moisture left in it by conventional methods. Even drier gas can be produced if you require it.

In working with controlled atmospheres of inert gases to prevent undesired reactions, this dryness of the gas at low cost is a great advantage. The cost of the Niagara method is low because it uses evaporative cooling, saving 95% of the cost of cooling water (and its piping and pumping). This direct saving of cost pays for the Niagara cooler in less than two years.



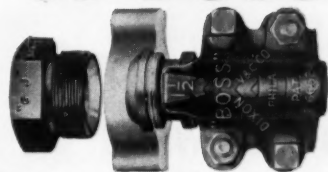
If you use compressed air to operate instruments or pneumatic equipment you will get better results by using the Niagara Aero After Cooler.

Write for Bulletin 130, or ask nearest Niagara Engineer if you have a problem involving the industrial use of air.

NIAGARA BLOWER COMPANY
Dept. CA-5, 405 Lexington Ave., New York 17, N. Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

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GROUND-JOINT FEMALE COUPLING, STYLE X-34

so *Reliable*
FOR PILE DRIVING

...AND ANY
**STEAM, AIR,
WATER AND
HYDRAULIC
SERVICES...**
**HIGH OR LOW
PRESSURE**



Washerless

Unequalled for safety, efficiency and long service life. Ground-joint union between stem and spud provides leak-proof, trouble-free seal... no lost or worn-out washers to replace. All parts malleable iron or steel, rustproofed. Furnished with superstrong "Boss" Offset and Interlocking Clamps. Sizes $1/4$ " to 6", inclusive.

COMPANION MALE COUPLING "BOSS" STYLE MX-16



Companion coupling for "GJ-Boss", described above, and "Boss" Washer Type Couplings Style W-16. Each size fits same size hose... oversize hose not required. Furnished with "Boss" Offset and Interlocking Clamp. Sizes $1/4$ " to 6", inclusive.

"BOSS" HOSE MENDER, STYLE BM-16



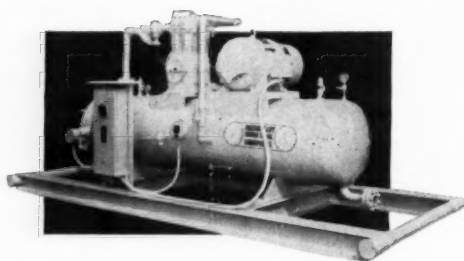
The practical, safe way to restore damaged hose to service. Fitting consists of corrugated mender tube and two "Boss" Interlocking Clamps. Tube has flanges to engage clamp fingers. Thoroughly rustproofed. Sizes $1/2$ " to 6"

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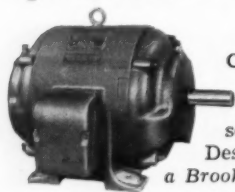
DIXON
Valve & Coupling Co.

GENERAL OFFICES & FACTORY—PHILADELPHIA 22, PA.
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DIXON VALVE & COUPLING CO., LTD., TORONTO Associate Companies
Buck Iron Company, Inc., Quarryville, Pa. · Precision Drawn Steel Company, Camden, N. J.

this unit to
"PUSH" OIL
OUT OF WELLS
is dependably



powered by a BROOK MOTOR

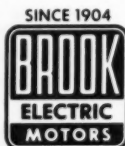


The unit shown, built by Pressure Lift Service Co., Inc., Shreveport, La., will "push" the oil up and out of as many as eight wells at one time. A Brook Open Drip Proof 15 HP a.c. motor was selected to provide dependable, economical power. Despite their modest cost there is no finer motor than a Brook. That is why so many petroleum producers and processors are profiting from Brook Motors. All standard enclosures—1 to 600 HP. Send for brochure.

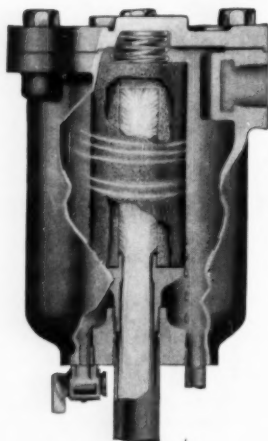
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EXCESSIVE AIR TOOL MAINTENANCE ?



The majority of air tool down time and maintenance cost can be traced directly to dirty compressed air. Rust, pipe scale and other foreign materials are picked

up from the air system by the moving air stream. This entrained debris is a sure source of trouble if allowed to enter your air operated equipment.

An Adams Poro-Stone filter is scientifically designed for maximum separating efficiency. Centrifugal forces trap entrained solids and liquids in the exclusive interior shell slots. They then drain into the lower liquid chamber for periodic removal. The gas then is completely cleaned as it diffuses thru the minute voids of the Poro-Stone element.

Throughout their operating range, they require only 1/2 PSI pressure drop—a negligible reduction from line pressure. Virtually no maintenance or servicing is required—assuring continued cost cutting, trouble free air.

Adams Poro-Stone air filters are available from stock in a wide range of sizes. Find out today how they can eliminate your compressed air problems. Write for Bulletin 117.

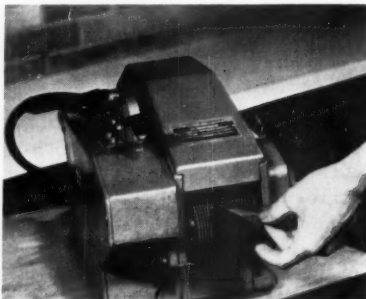
R. P. ADAMS CO., INC.

209 East Park Drive

• Buffalo 17, New York

ceedings of the Third International Coal Preparation Congress, held at Leige, Belgium in June 1958, has been issued. Eight hundred members representing 23 countries attended the Congress where 67 papers were presented, having a total of 127 authors. The volume contains final versions of the papers and discussions, speeches, list of members, and general reports. It has 790 pages with 700 figures, and deals with the present state of coal preparation in the world. Copies may be obtained by applying to the institute. Cost to non-registered members is 600 Belgian francs; to registered, 200 francs. *Institute National de l'Industrie Charbonniere, 7 Boulevard Frere-Orban, Liege, Belgium.*

TAPE DISPENSERS designed for large-volume taping operations have been introduced by Minnesota Mining & Manufacturing Company. Called Scotch brand air-operated definite-length dispensers and available in fourteen models, these portable machines automatically dispense pressure-sensitive tape to almost any present length—right into the hands of the operator for fast application. All of the machines, which range in weight from 22 to 74 pounds, can be equipped with four different types of valves: an air valve activated by foot, hand, arm, knee or conveyed product; an air-operated valve with a time-delay switch, activated by slight finger pressure which sets in motion a tape delivery cycle that dispenses the tape and completes the motion automatically; and



an air-electric valve, activated by simply removing a strip of tape from the machine. The removal action triggers the switch that sets in motion the automatic tape delivery cycle that completes itself. The units are designed to reduce tape waste by reducing time and effort of dispensing, and to increase taping efficiency by allowing more time for the taping application. Their finely ground, unexposed blades prevent operator's fingers from being injured during rapid dispensing and assure neat, trim strips of tape. It is reported that each machine can be operated for only a few pennies a day. All can be readied for instant use simply by attaching them to almost any

factory or office air line. Since they are available complete with air hoses, valves, regulators, gauges and other necessary attachments, there is no need to purchase extra fittings. The company's booklet No. P-IADLF explains the units in detail. *Minnesota Mining & Manufacturing Company, Department JO-103, 900 Bush Avenue, St. Paul 6, Minn.*

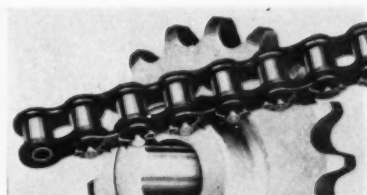
SELECTION of drive screws and nails is easy with the sample board offered without charge by The Hillwood Manufacturing Company. The 12x16-inch



plaque can be hung on the wall or stood up on a counter for quick, easy reference. Mounted on it are samples of 23 nails of different sizes, in six different types. Below each is printed the number of nails in a pound. Uses for each type are also described. Nails displayed include: Helyx drive screws, all-purpose fasteners for general construction; Helyx concrete screws, which need no drilling or plugging for driving directly into concrete masonry or block; Helyx floor screws, for fastening all types of hardwood flooring; Spyrol drive screws, used in general construction for drywall, plasterboard, cedar shakes, shingles and underlayment; Rol-thread nails for general construction, rugged pallet making, and general box assembly; and Ring barb nails for drywall, underlayment, etc. *The Hillwood Manufacturing Company, 21700 St. Clair Avenue, Cleveland 17, Ohio.*

SEAMLESS steel tubing and electric welded steel tubing are described in an 8-page 1960 catalog (CS-60) offered by Ohio Seamless Tube Division of Copperweld Steel Company. Carbon and alloy steel grades of seamless tubing are detailed in mechanical, pressure, aircraft mechanical and airframe categories.

Carbon steel grades of electric welded steel tubing are reviewed in mechanical and pressure divisions. In addition, a section covers fabrication and forging of steel tubing into finished or semi-finished tubular parts and components. The brochure is available without cost. *Copperweld Steel Company, Ohio Seamless Tube Division, Shelby, Ohio.*

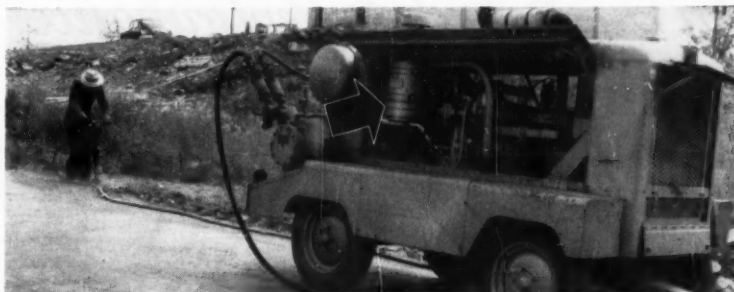


STOCK sizes of Link-Belt roller chains and sprockets, available for immediate delivery in every major industrial area, are conveniently listed in a 44-page book, No. 2757, just released by the manufacturer. Keydexed for easy reference, the

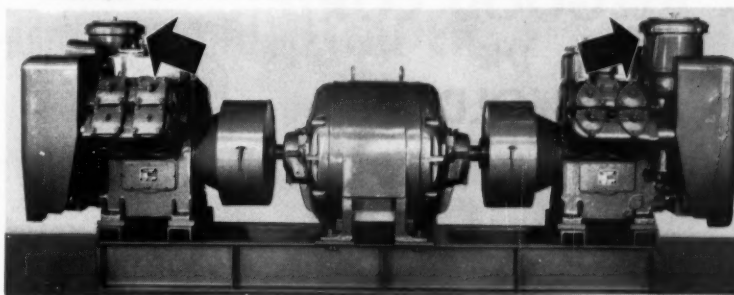
book lists more than 2000 types and sizes of roller chains and sprockets, including standard and double pitch power transmission chains, a large selection of conveyor chains and attachments, and one of industry's most complete lines of sprockets—all off-the-self items. An 18-

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page section lists stock sizes of standard roller chains—single, double, triple and quadruple strand—together with heavy series roller chains, corrosion-resistant stainless steel and bronze roller chains, double pitch roller chains, various types of flat-top conveyor chains, and leaf chain. Sprockets described in a 20-page section include the finished-bore, taper-lock, mandrel-bore, Type-D (removable segments), and shear-pin types. Two pages are devoted to RC roller chain flexible couplings. A copy of *Link-Belt Chains and Sprockets* may be obtained without charge. *Link-Belt Company*, Department PR, Prudential Plaza, Chicago 1, Ill.

Films . . .

Specialty Steels is a 45-minute color film that tells the story of the science and art that goes into producing special-purpose steels, such as stainless steels and tough-wear and shock-resistant steels for the tool room. Photographed at Crucible's mill at Midland, Pa., 34 miles west of Pittsburgh, cameramen had to wear steel helmets, goggles and gas masks as they pushed close to the electric melting furnaces to catch the drama of molten steel. (Incidentally, exposed and unexposed film was stored in a portable Coca-Cola refrigerator during the shooting of the scenes because of the intense heat.) Community and industrial groups interested in seeing the film, which is accompanied by a special score played by the Zurich Symphony Orchestra of Switzerland, may contact the Information Services Department, Crucible Steel Company of America, Pittsburgh 22, Pa.



"There's nothing wrong with the winch, I'm just looking for my nickel."



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CONTROL
Air or
Liquid
CONTROLLED
BEST
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New Jersey
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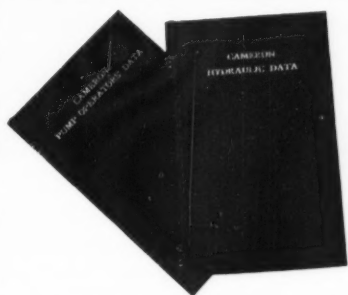
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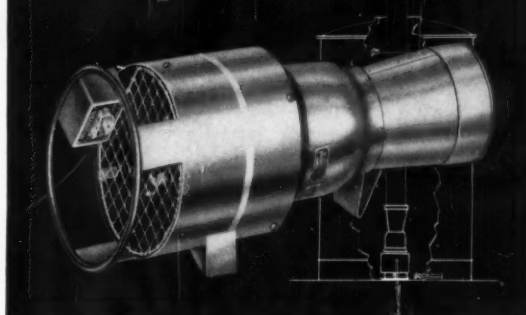
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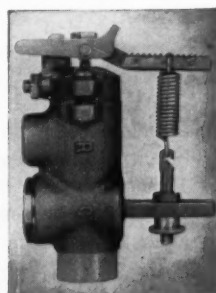
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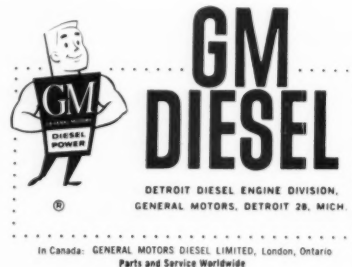
It doesn't take long for blowing sand and dust to separate the men from the boys in the engine league. And you can take it from "Bud" Mentzer, Equipment Superintendent for Phoenix' Fisher Contracting Corp., that "Jimmy" Diesels do a man-sized job even under these tough conditions.

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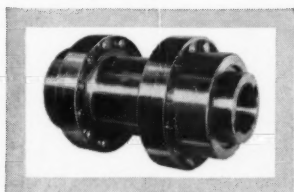
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GM DIESEL ALL-PURPOSE POWER LINE

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Waldron high speed couplings are now operating at speeds of 70,000 rpm and more, and in drives up to 48,000 HP.

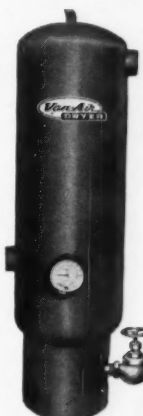
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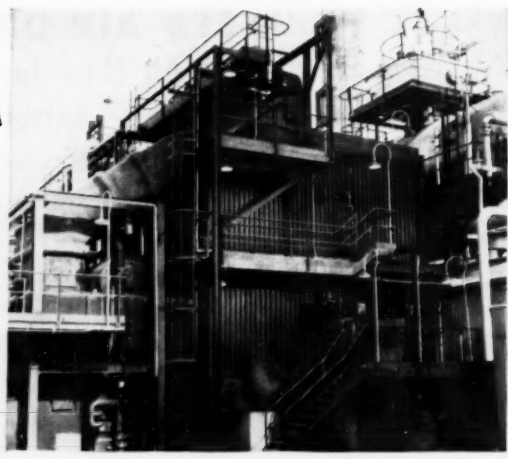
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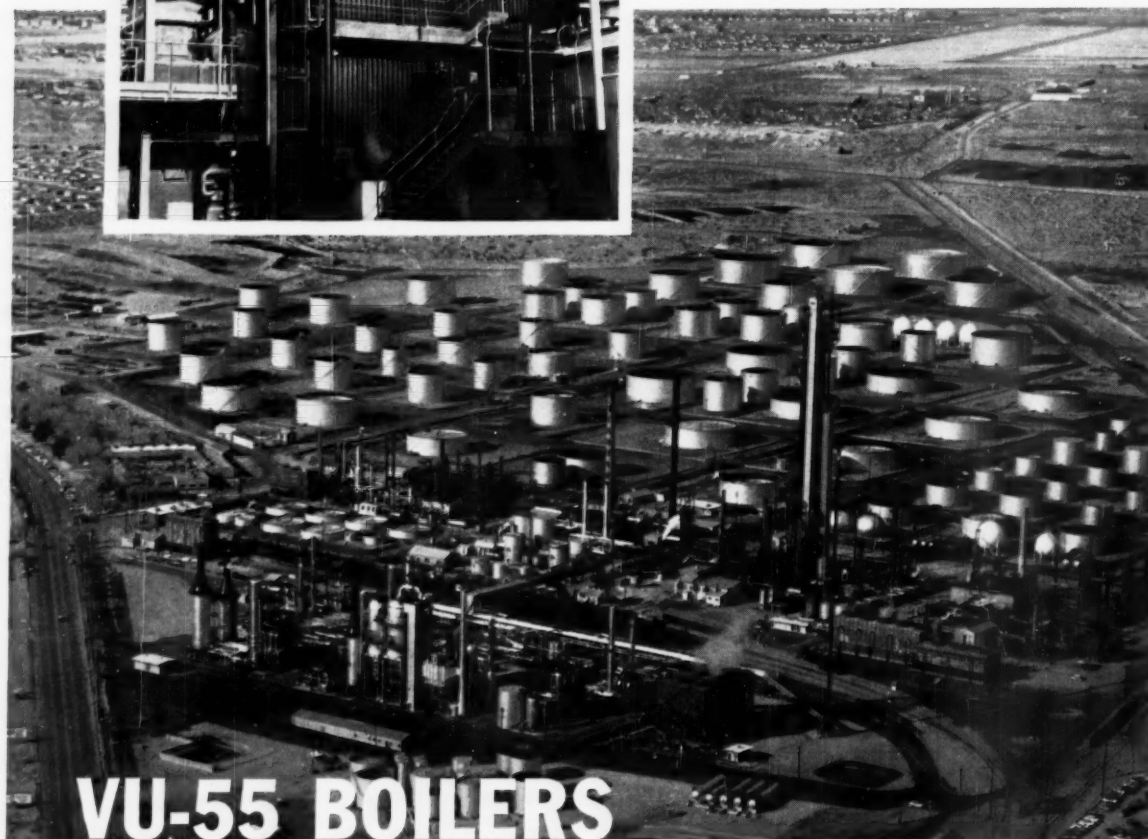
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One of the two identical C-E Vertical-Unit Boilers, Type VU-55, installed at the El Paso Refinery of Standard Oil Co. of Texas. These "outdoor" type units are designed for a continuous capacity of 80,000 lb of steam per hr at 400 psi and 550 F. They are designed for pressurized firing and are fitted with tangential burners for the most efficient utilization of oil and gas.



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Handle Load Swings Smoothly

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These units have proved to be the keystone of the refinery's steam supply as they were soon recognized for their exceptional ability to handle load swings and to meet overload demands smoothly and efficiently.

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Refinery, including two other C-E units of smaller size, but the VU-55's have established the best record for reliability and ease of operation. As a matter of fact, the VU-55 Boiler, especially designed for use with oil or gas fuel, is making a consistently good record in numerous installations both in this country and abroad. So — when you are in the market for a new boiler — oil or gas fired — in a capacity range from 70,000 to 150,000 lb of steam per hr — investigate Combustion's VU-55.

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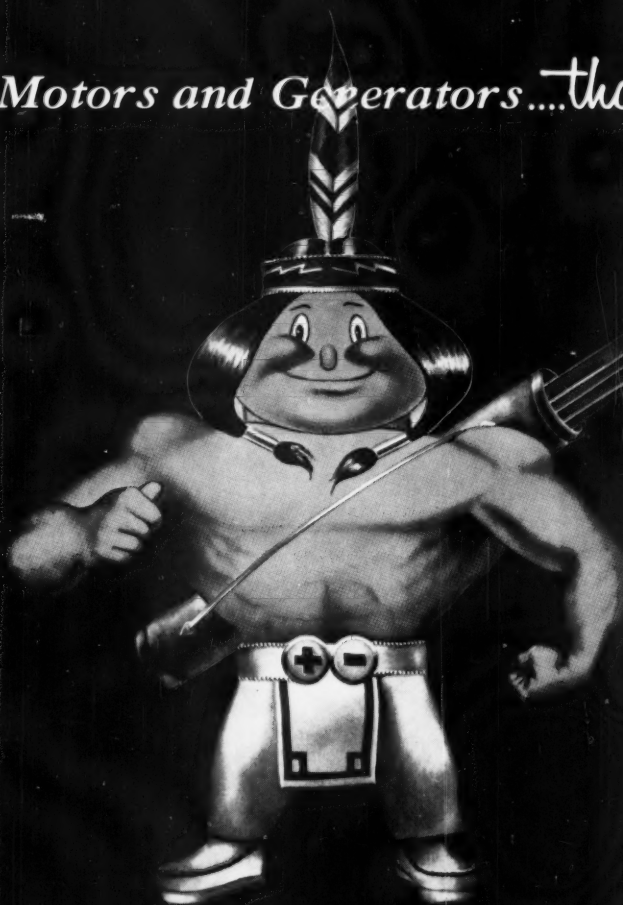


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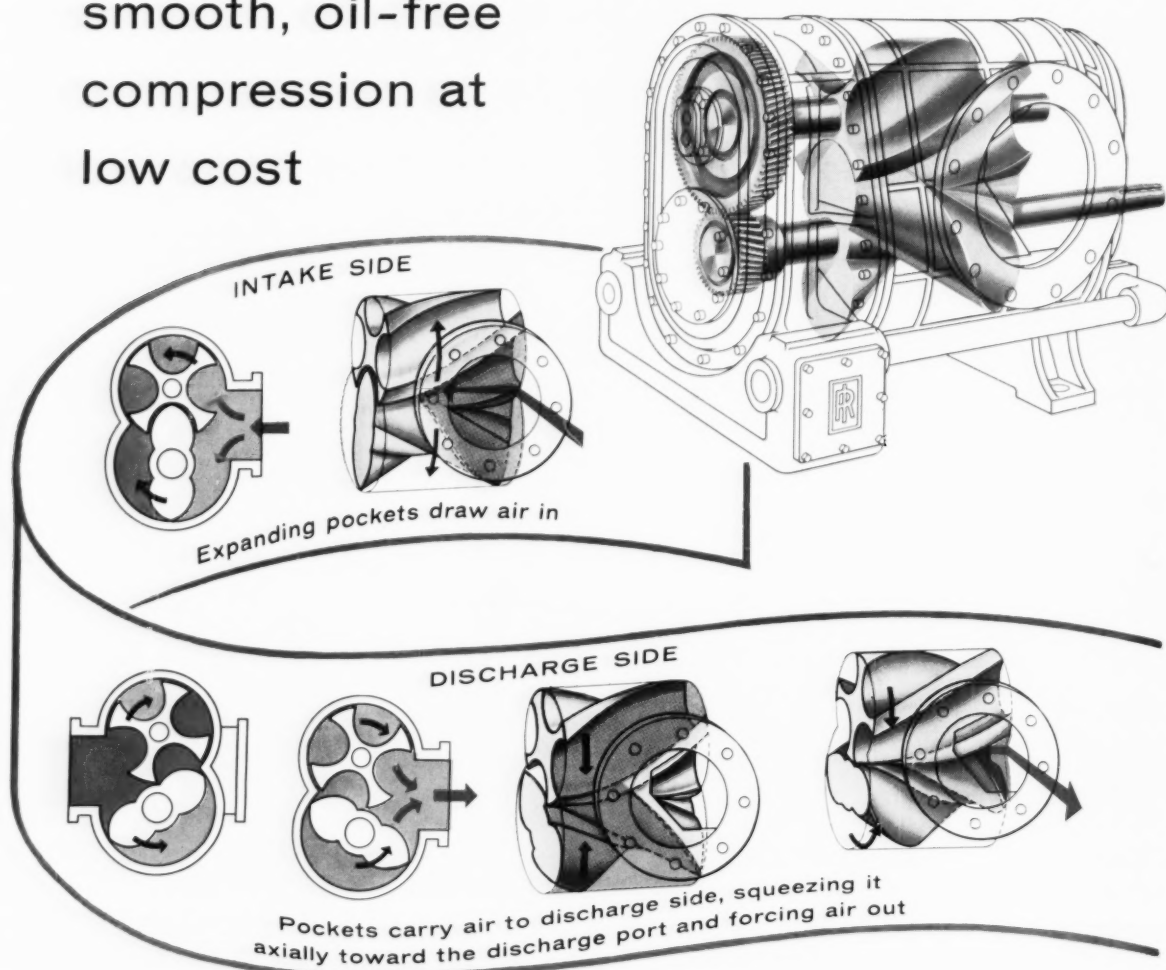
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